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SURGERY

ITS

THEORY AND PRACTICE

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BY

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WITH 410 ILLUSTRATIONS

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PREFACE TO THE SIXTH EDITION.

HE continued popularity of this work as evidenced by its ever creasing sale, has permitted a further enlargement in the size the volume and a considerable addition to the number of e illustrations, thus enabling the Author to give much new atter and to amplify the old where it seemed necessary. This s especially been the case with regard to the sections on eneral Pathology, Diseases of the Joints, Abdominal Surgery, juries of the Head, and Genito-Urinary Diseases.

In the revision of the sections on Pathology and Bacteriology, e Author has been most ably assisted by his friend and rmer colleague, Dr. Kanthack, now Professor of Pathology in e University of Cambridge, who has again brought these bjects completely up to date. He has received valuable help roughout the rest of the work from Mr. W. G. Spencer, urgeon to the Westminster Hospital, Mr. W. E. Miles, ssistant Demonstrator of Anatomy at St. Bartholomew's ospital, and Mr. Stack, F.R.C.S. To Mr. Miles he is further debted for his kindness in reading the proof-sheets.

Most of the new illustrations are from preparations in the . Bartholomew's Hospital Museum.

77, Harley Street, W.,
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SURGERY;

ITS

THEORY AND PRACTICE.

SECTION I.

General Pathology of Surgical Diseases.

INFLAMMATION.

Inflammation was defined by Dr. Burdon Sanderson as "the succession of changes which occurs in a living tissue when it is injured, provided that the injury is not of such a degree as at once to destroy its structure and vitality." This definition is defective in that it states only the reason why these changes occur, not their purpose. The purpose of inflammation is to antagonize or remove irritants and prepare the way for reparation—or a return to the normal. Inflammation is therefore, perhaps, better defined in the words of Professor Adami as "the series of changes constituting the local manifestation of the attempt at repair of actual or referred injury to a part," or briefly, as the local attempt at repair of actual or referred injury. Inflammation may occur in any tissue of the body, and in whatever tissue or organ it occurs, whether superficial or deep, transparent or opaque, vascular or non-vascular, soft or hard, the pathological process is essentially the same.

General outline of the process.—Let us first study the process as it may be observed by the naked eye, say, in a portion of inflamed skin. The part is uniformly red, hotter than the surrounding skin, swollen and painful. The redness momentarily disappears on pressure, and gradually fades away into the natural colour of the part around, but later it becomes mottled, and in places of a deeper hue. There is usually some œdema about the inflamed spot, and the neighbouring lymphatic glands may be slightly tender and enlarged. If an incision were now made into the inflamed tissues, they would be found fuller of blood than natural, of a bright red colour, and infiltrated with serum; whilst if the lymphatics leading from the part were opened, as has been done in animals, they would be seen to be transmitting more lymph than under normal conditions. The inflammation may now terminate, leaving the tissues apparently normal (*resolution*), or it may lead to certain changes producing irreparable damage to, or total destruction of the part. Thus, the damaged tissue may be replaced by thickened or indurated tissue, and a condition result which is generally described as one of chronic inflammation (*fibroid thickening*); or the tissues in the centre of the inflamed spot may soften and break down, forming a creamy fluid called pus (*suppuration and abscess*); or the more superficial tissues may undergo molecular destruction, leaving a raw surface (*ulceration*); whilst again the whole of the tissues in the inflamed area may lose their vitality and die "en masse" (*gangrene*). When the inflammatory process is at all severe, constitutional symptoms will also be present. Thus, the temperature will be more or less raised, the skin dry, the pulse increased in rapidity, the tongue furred, the appetite lost, the bowels confined, and the urine scanty and high-coloured—a condition known as *inflammatory fever*, and due in almost every case to the absorption of some poison (*intoxication*). Under some circumstances the constitutional symptoms may be of a more serious character, and secondary inflammations may be set up in internal organs or in other parts of the body: the patient is then said to be suffering from *septic* or from *infective poisoning*, conditions which, as will be pointed out hereafter, are due to poisonous bacteria or their products entering the general blood-stream or the lymph-channels at the primary seat of inflammation.

The *minute changes* that occur in the above described phenomena have of late years been very accurately studied in the tissues of the frog, rabbit, dog, and other animals, and in sections of the cornea and tongue of the frog. They differ according to whether the inflammation occurs in a vascular or non-vascular area.

(*a*) *In a non-vascular area, e.g.*, the cornea, necrosis followed by proliferation of the fixed cells may be the only recognizable factor in the process of repair of injury; or there may be an immigration of leucocytes, attracted by a process of chemiotaxis to the region of cell destruction. In a more intense inflammation, such as that produced by pyogenic micro-organisms, the cell degeneration is followed by a determination of leucocytes to the seat of injury, the leucocytes travelling along the corneal lymph-channels from the congested vessels at the periphery of the cornea, having been attracted towards the inflammatory focus by some unknown force (*chemiotaxis*). Many of the leucocytes take up micro-organisms (*phagocytosis*), others degenerate, and at the same time the destruction of the corneal tissue progresses. An arrest of the process is brought about by the leucocytes massing together in large numbers, so as to offer a barrier to the micro-organisms. Newly-formed capillaries appear at the periphery of the cornea, and extend towards the injured part, and the corneal corpuscles outside the area of destruction undergo proliferation, thus initiating the repair of the tissue.

(*b*) *In a vascular area* the inflammatory changes also vary with the severity of the injury. In slight and superficial lesions vascular changes, such as congestion, emigration of leucocytes, diapedesis, and exudation are little marked, but the fixed cells of the tissue hypertrophy and proliferate. In lesions of greater severity the vessels become congested, and leucocytes quickly appear, wandering to the seat of injury through the vessel-wall by a process of diapedesis. The vessels, first the arteries and then the veins, dilate, and there is a very marked acceleration of the blood-flow (*determination of blood or active hyperœmia*), and smaller vessels and capillaries which were previously invisible are now seen transmitting blood. Hence the redness of the part.

Now, after a longer or shorter period, according to the kind of irritant used to set up the inflammation, the blood-current slackens, at first in the veins and then in the capillaries and arteries, and leucocytes are seen to drop out here and there from the central stream or axial current, which appears yellowish in colour from the red corpuscles being contained in it. These truant leucocytes first roll lazily along in the pale or circumferential current, and are joined by more and more as the blood-stream further slackens in speed. Now they adhere to the walls of the veins, and to a less extent to the walls of the capillaries and arteries, so that the vessels appear as if lined with them. Soon they begin to pass through the vessel-walls into the tissues around (*diapedesis*), attracted according to some writers to the seat of inflammation by the poison or chemical irritant which has excited it (*positive chemiotaxis*). By-and-by, if the inflammation is very acute, the coloured corpuscles, in groups of two to a dozen, also leave the central stream and pass through the walls of the vessels into the tissues, producing those patches of darker redness and the mottling of the surface alluded to above. The central stream next begins to oscillate, flowing onwards during the systole, and slightly receding during the diastole of the heart; whilst the coloured corpuscles show a tendency to adhere to one another. Finally the stream stops, and *stasis* is said to have occurred (Fig. 1).

In the meantime the liquid contents of the vessels have also been passing through the vessel-walls into the tissues, and, together with the escaped leucocytes, account for the swelling and for the *serous exudation* which can be squeezed out when the parts are cut into. The serum, further, soaks into the neighbouring healthy tissues, thus explaining the surrounding œdema, and is thence, along with some of the leucocytes, taken up by the lymphatics, and so passes back into the circulation. If now the cause of the inflammation ceases to act, and the vitality of the tissues has not been too much lowered to permit of their recovery, the corpuscles in the middle of the stream in those vessels where stasis has occurred again begin to oscillate and then to move on; the leucocytes no longer drop out of the axial current, and those that have already escaped into the tissues either break down or pass along with the escaped fluids into the lymphatics, leaving the part apparently uninjured (*resolution*).

If the above favourable termination does not take place and stasis is not soon relieved, coagulation of the serum may ensue, and the vessels become thrombosed. At the same time, moreover, coagulation of the liquid exudation in the tissues also occurs. The clot thus formed contracts, squeezing out the serum, which is then drained away by the lymphatics, so that if the parts at this stage be cut into, a serous exudation will no longer escape. The original tissues, partly in consequence of the plugging of the vessels, and partly in consequence of the digestive action of the leucocytes and soddening effect of the fluid exudation, become swollen and softened, and finally lose their vitality and disappear, their place being taken by a mass of closely-packed small cells embedded in a very slight amount of intercellular substance. This small-cell-infiltration has been ascribed in part to the aggregation of leucocytes and in part to the proliferation of the connective-tissue and other cells in the

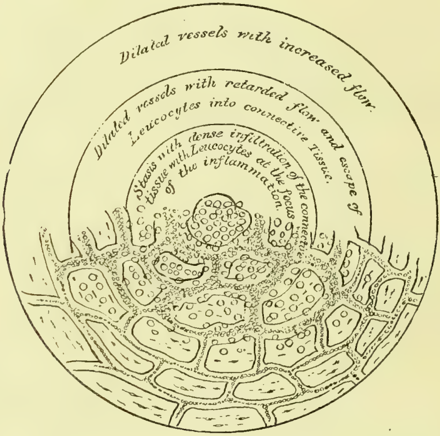
Dilated vessels with increased flow.
Dilated vessels with retarded flow and escape of
Leucocytes into connective Tissue.
Stasis with dense infiltration of the connective
tissue with Leucocytes at the focus
of the inflammation.

Fig. 1.—Diagram of the minute changes in inflammation.

inflamed area, the leucocytes forming, nevertheless, its chief constituent. Among these small round cells, especially during the stage of reparation, may soon be seen numerous delicate capillary loops, which have been formed from the old capillaries in and around the inflamed area, or from the young endothelial or connective-tissue cells. To this vascularized tissue the name of inflammatory new formation or granulation tissue is given. When the cells and liquid escape on a free surface, the fibrin with the entangled cells forms a so-called false membrane.

Changes in the fixed elements of the tissues.—When the mesentery is examined after inflammation has existed a short time, the cells of the original tissue are found to present two opposed changes, viz., both degeneration and proliferation, the former being visible chiefly at the focus of irritation, and the latter towards the boundary zone. The cell destruction is in part the direct result of the injury, and as such not a phenomenon of inflammation, but it is in part directly due to the interference with their nutrition, produced by the inflammatory processes, such as stasis and œdema, bacterial activity, and leucocytic digestion. The degenerated cells, if the lesion ends in repair, are removed, being either cast off or absorbed by the leucocytes. While these degenerative changes take place, proliferation of the original tissue cells goes on concurrently, especially at the periphery of the inflamed area. The connective-tissue cells enlarge and multiply, and then intermingle with the leucocytes, so that the newly-formed granulation tissue is made up of two kinds of cells, viz., connective-tissue derivatives and leucocytes. The latter disappear and are in part absorbed by the proliferating connective-tissue cells, which, as the inflammation approaches repair, become spindle-shaped and are called fibroblasts, because they eventually become connective or fibrous tissue. So far as the higher warm-blooded animals are concerned, there is but little doubt that these fibroblasts are of connective-tissue origin, and that connective tissue develops from connective tissue alone, but in lower cold-blooded animals leucocytes can be seen to develop into connective tissue.

The leucocytes have special duties of their own to perform. Some varieties of them attack and ingest bacteria or other foreign matter and dead or necrosed cells. They wander to the seat of irritation, attracted, as it is assumed by some, by the chemical products of the bacteria (*chemiotaxis*) and seize upon the *materies morbi*, or at least attack it (*phagocytosis*), and if they succeed in destroying it the inflammation is brought to an end. Metchnikoff regards "inflammation as a phagocytic reaction of the organism against irritants." There are, however, leucocytes which are not phagocytic, and these are capable of exerting an extracellular activity upon bacteria and other matter. Thus, pus corpuscles, which are nothing else than leucocytes, are strongly proteolytic, *i.e.*, they can digest and peptonize albuminous substances, and even dissolve metallic particles. So that it is evident that the activity of leucocytes is twofold, both intracellular or phagocytic, and extracellular or chemical. It may be remarked here, that besides certain forms of leucocytes, the endothelial cells of the capillaries and many fixed and wandering connective-tissue cells also possess phagocytic properties. The latter, being large in size, were formerly called *macrophages*, in contradistinction to the *microphages* or leucocytic phagocytes.

Another important phenomenon of inflammation, which has already been mentioned, is the *exudation* or transudation of fluid from the blood-vessels. The amount of fluid exuded varies with the density and structure of the tissues, being generally copious in serous membranes and also in loose vascular tissues, but scanty in dense tissues. The purport of the exudation is partly to dilute the irritant, partly—where an inflammation is superficial—to wash it away. In its chemical constitution it resembles plasma, but it generally also contains proteolytic ferments, peptones, and where bacteria are present also their products. Fibrin is also present as a rule, and sometimes in such quantity, that the exudation, instead of being *serous*, becomes *fibrinous*. The ferments capable of digesting proteids are secreted not only by bacteria which may be present, but also by the leucocytes; these no doubt assist in the removal of the dead tissues. Bactericidal substances also derived, from leucocytes, and capable of destroying or inhibiting bacterial growth, may frequently be found in the inflammatory exudation.

There can be no doubt that the vascular changes, the exudation, and leucocytic phenomena accompanying inflammation can occur independently of central nervous influences, for in a rabbit's ear, after section of all its nerves, irritation will produce an intense inflammation. It would, however, be incorrect to say that the nerves have no direct influence, for it is well known that when all the nerves of a part have been divided, the stages of inflammation succeed each other with greater rapidity, because in such a case, the vaso-dilators are especially called into action, the injury of the nerve producing a marked hyperæmia. Speaking generally, however, the vessels of an inflamed area react independently of the central nervous system, but respond rather to the control of peripheral nervous filaments or to a direct stimulus applied to the endothelium or muscular wall.

TERMINATIONS OF INFLAMMATION.—We have already seen that if the cause of the inflammation ceases to act before the tissues have become irreparably damaged, the process may terminate and the part resume its normal condition, when *resolution* is said to occur. Failing this, however, the following terminations may ensue. Thus, under favourable circumstances, the cells constituting the inflammatory new formation may gradually become converted into fibrous tissue, producing the condition already referred to of *fibroid thickening* or *scarring*. Under less favourable circumstances the immigration of leucocytes continues until the tissue becomes densely packed; if bacteria are present they also multiply; the tissues are digested and destroyed; the leucocytes, now called pus corpuscles, degenerate and in part break down, while others appear; the exudation of lymph or plasma continues as before, but the tissues and leucocytes themselves "liquefy" as well, so that the final result is a thick viscid fluid (*liquor puris*) containing healthy and degenerate leucocytes (*pus corpuscles*). Thus pus is formed, and *suppuration* is said to be established. When these changes occur on the surface of the skin or mucous membrane, so that the products escape externally, the process, though essentially similar to that of suppuration, is spoken of as *ulceration*. And lastly, the infiltrated tissues in the centre of the inflamed area may lose their vitality and die *en masse*, before infiltration with leucocytes and serum has gone on sufficiently long to produce their softening; *mortification* or *gangrene* is then said to result.

Causes of inflammation.—The cause of inflammation is irritation, and its object to remove irritation. Irritants acting in any way may be looked upon as exciting causes, and would appear in some instances to be alone sufficient to set up the process. In other cases, however, certain prior conditions such as may be considered to lower the vitality of the tissues, and to render them less able to resist deleterious influences, appear necessary to render such irritants operative. Among such *predisposing* causes may be mentioned: 1. A deficient supply of healthy blood caused by insufficient or improper food and air, a feeble action of the heart, hæmorrhage, anæmia, and the like. 2. The presence of impurities or of certain poisons in the blood, such as exist in chronic alcoholism, Bright's disease, diabetes, gout, syphilis, and in lead, mercury and phosphorus poisoning. 3. Deprivation of healthy nerve influence, as from disease or injury of a nerve-centre, or nerve-trunk. 4. Old age. 5. The so-called strumous diathesis.

The *exciting causes*, which are usually spoken of as irritants, may be considered under the following heads: 1. Direct violence and physical irritation. 2. Chemical irritants. 3. Micro-organisms—saprophytic and parasitic. Micro-organisms, however, also act chiefly by their chemical products.

1. *Direct violence and physical irritation.*—Under this head are included all forms of mechanical injury; excessive heat or cold; electrical stimulation; the application of strong acids or alkalies, or of irritating products, as croton-oil or mustard; friction, and tension. All of these are now admitted to be exciting causes, the irritants being the chemical products of injured or destroyed cells.

2. *Chemical irritants.*—The chemical products of putrefaction would appear to play an important part in the causation of inflammation. For fermentation or putrefaction to occur, there must be dead animal matter, a sufficiency of water and oxygen, the maintenance of a certain temperature, and the presence of a ferment. This ferment consists of living microscopic organisms, species of bacteria known as saprophytes, which exist in large numbers in the air, water, &c., in short everywhere, except perhaps in mid-ocean and above the snow line, and are especially numerous in large cities, hospitals, &c. It is not thought, however, that the inflammation is lighted up by the bacteria themselves, but by the chemical products which are formed in the process of fermentation or putrefaction, and which soak into the surrounding tissues, acting like any irritant fluid or the poisonous alkaloids. For it has been found that when a fluid swarming with these bacteria (*saprophytes*) is injected into the blood or connective tissue of a living animal, the bacteria rapidly disappear without causing inflammation or other ill-effect. Again, if a similar fluid is injected into the peritoneal cavity in such quantities only as to allow of its rapid absorption, no inflammation ensues. On the other hand, if such a fluid or even water is injected in greater quantities than can be rapidly absorbed, serum from the blood is effused into it; and as all the essentials for putrefaction are now present, viz., diluted serum, which constitutes the dead animal matter, heat, moisture, oxygen, and saprophytic bacteria to act as a ferment, putrefaction ensues. Thus, to sum up, it is inferred from these and similar experiments that the saprophytic bacteria themselves are incapable of setting up inflammation; that they are only able to thrive in dead animal matter, and not in living tissues; and that it is the products of putrefaction, of which they are believed to be the cause, that set up the inflammatory process.

3. *Micro-organisms.*—These, which include the various species of micro-organisms, known as pathogenic or parasitic bacteria, play an important *rôle* in the causation of most inflammations. But whilst it cannot be admitted that they are the exciting cause of all inflammations, the belief is almost universal that they are important, if not the chief agents in many inflammations, and especially in those inflammations which, because they occur without any apparent cause, were formerly spoken of as *idiopathic*. Thus erysipelas and some forms of osteomyelitis and periostitis depend upon them, and malignant pustule has also been proved to do so. They are always found in acute suppurative inflammation. Unlike the saprophytes, the bacteria which are found in all decomposing fluids, and which as we have seen are unable to exist in the living tissues, the parasitic bacteria are not only capable of living in such tissues, but thrive and multiply in them, and whilst doing so give

rise to certain irritating chemical products which set up inflammation. Hence their name, *infective, parasitic*, or *pathogenic* bacteria. They not only multiply and spread in the surrounding tissues, setting up inflammation in their course, but also in some instances enter the system by the blood or by the lymph-vessels, where, still multiplying, they poison the body generally, and in consequence of their becoming lodged in the capillaries of various tissues or organs of the body where they further multiply and thrive, set up there a like inflammation. The way in which they enter the body is either by a wound direct, or else by the alimentary or respiratory mucous tract, or even by the numerous glandular pores of the skin. Where they enter by a wound, it appears that decomposition of the discharge favours their entrance (as in erysipelas occurring in a septic wound), though such is not essential. They or their spores are supposed to exist in the air, water, &c., but in less quantities than the saprophytic bacteria.

Many micro-organisms, as already mentioned, require oxygen of the air for their development, and are then called *aërobic;* whilst others only thrive when protected from access of oxygen and are known as *anaërobic.*

As the various species of bacteria will have to be frequently mentioned they may be here briefly described. The *bacteria* belong to the group of protophytes, the simplest of vegetable organisms. They are conveniently divided into: 1, micrococci or spherical bacteria; 2, bacilli or rod-shaped bacteria; and 3, spirilla or spiral bacteria. *Micrococci* are round or oval bodies; they occur singly or in pairs. When in pairs they are called diplococci, an example of which we find in the gonococcus. Sometimes they form chains, and are then termed streptococci, *e.g.*, *Streptococcus pyogenes;* or they may occur in grape-like colonies (*zooglœa masses*), and are then spoken of as staphylococci, the best known being the *Staphylococcus pyogenes aureus.* They multiply by fission or division. *Bacilli* are rod-shaped microbes; some of them multiply by spores as well as by fission. Hence a bacillus may at one period of its development be rod-shaped, whilst at another it may be round like a micrococcus. The spores which are developed in the interior of the bacillus are liberated by its destruction and then, if the conditions are favourable, germinate and assume the shape of the fully developed organism. The spores have a greater resistance to external influences, heat and chemicals, than the bacillus from which they are formed. The *spirilla* are of no surgical interest, and will not be further mentioned. Both bacilli and micrococci may be divided into (*a*) saprophytic, and (*b*) parasitic bacteria.

(*a*) The strictly *saprophytic bacteria* only live on dead or dying organic material or in solutions of the same, and are incapable of thriving in the living tissues. Some species by means of the activity of their protoplasm not only obtain food from the dead organic material and multiply, but cause changes in the fluid in contact with their surface known as fermentation. To this is due the decomposition of serum or of pus retained in a wound, the conversion of milk-sugar into lactic acid in the souring of milk in the stomach, and the resolution of urea into carbonate of ammonium and consequent production of ammoniacal urine in the bladder. These micro-organisms by their growth and metabolism elaborate substances either within themselves (*intracellular poisons*) or in the medium in which they are growing, and these substances act as irritants to the living tissues, setting up inflammation, or, if absorbed, give rise to symptoms somewhat similar to those produced by the poisonous alkaloids.

The short rod-like body always present in myriads in a drop of decomposing fluid was formerly known as *Bacterium termo*, or the bacterium of putrefaction. More recently it has been shown that not one but many species of micro-organisms were confounded under the term. Most of these organisms have been but imperfectly investigated and are consequently still unnamed.

Other bacteria, instead of setting up fermentation, produce pigment, as for example, the bacillus of blue or green pus.

(*b*) The *parasitic bacteria* reside in living organic material and derive their food from the fluids of the circulation or from the protoplasm of the living cell. Some of these are only capable of thriving in living tissues (*obligatory parasites*); others, though occasionally found in living tissues, are as a rule found in dead organic material (*facultative parasites*). Parasitic bacteria may be divided from a pathological point of view into the non-pathogenic, which exist in the body without doing any harm, and the pathogenic, which produce disease either by their direct influence or by their chemical action. *Pathogenic bacteria* include: 1, those which are capable of attacking a healthy though susceptible organism, as the anthrax bacillus; and, 2, those which develop when the life energy of the cells of the organism is depressed, or when the tissues in which they live are altered, as the tubercle bacillus. In the former the special properties of the bacteria, and in the latter the predisposition of the organism to attack, are the determining factors. The bacteria, having gained admission, may merely affect the tissues at the place of entry, setting up a local inflammation; or they may extend by the lymphatics to the nearest lymphatic gland, where they may be arrested or pass through it and thus enter the circulation; or they may make their way into the small veins, and so gain the circulation at once, and become lodged, according to the nature of the bacteria, in the capillaries of various tissues and organs. Bacteria growing in connection with a mucous membrane may extend along the surface as in diphtheria; or may be carried from one point to another, as, in phthisis, from the lungs to the larynx or intestine. Diseased tissues produced by one kind of bacteria may be secondarily infected by another kind; thus the lung affected by croupous pneumonia may sometimes be secondarily infected by tubercle bacilli, and the tuberculous tissue by the micrococci of suppuration.

The tissues may be protected against the development of micro-organisms by the normal resistance of the body to the process of disease (*natural immunity*), or by an acquired resistance (*acquired immunity*). Of acquired immunity there have been several explanations offered. Thus it is believed that it may be brought about (*a*) by the exhaustion of the soil, *i.e.*, the occurrence of a disease once is thought to protect against a second attack through the first disease having exhausted the supply of the material which is necessary for the development of the micro-organism of that particular disease; (*b*) by the chemical products formed *pari passu* with the bacteria acting as a poison to the bacteria and preventing their development; (*c*) by certain chemical constituents in the blood-serum which destroy the bacteria; (*d*) by the leucocytes collecting around the bacteria, and so killing them; and (*e*) by the leucocytes and tissue-cells absorbing and destroying the bacteria (*phagocytosis*). Metchnikoff and his pupils hold that the leucocytes are endued with a peculiar power of protecting the organism, that they are attracted by the bacteria or their products (*chemiotaxis*), gather round them, absorb them into their substance, and so digest or destroy them. Other pathologists hold that the bacteria are first killed or weakened by the chemical products generated by the bacteria or by the disinfecting constituents in the blood-serum, and then only when dead or disabled are absorbed by the leucocytes and tissue-cells, and along with the devitalized tissues are in this way got rid of. The process of immunity cannot be discussed in this work, but it may be assumed with safety that immunity must depend on the power of the tissues, their cells and juices, to destroy the bacterial growth, and also to neutralize the bacterial poisons; *i.e.*, with acquired immunity the body acquires both germicidal and antitoxic properties. An immunity may be produced by gradual administration of increasing doses of toxins or by a single administration of so-called antitoxins, bodies derived from the serum of a highly immunized animal. Antitoxins are now used in surgical practice in tetanus, erysipelas and pyogenic lesions, such as suppuration, gangrenous cellulitis, septicæmia and pyæmia, and also in diphtheria. It is therefore necessary to understand the principles of the antitoxic treatment, but this discussion finds its most suitable place in the chapter on Tetanus.

Amongst the pathogenic bacteria of surgical interest may be mentioned: the anthrax bacillus, the cause of malignant pustule;

the tubercle bacillus, found in tubercular disease; the bacillus of glanders, of leprosy, of tetanus, of diphtheria, and of rhinoscleroma; the *Staphylococcus pyogenes aureus*, and the *Streptococcus pyogenes*, the organisms found in connection with suppuration; the *Streptococcus erysipelatosus;* the *Micrococcus gonorrhœæ* and the fungus of actinomycosis.

SIGNS AND SYMPTOMS of inflammation. These may be divided into the local and the constitutional. The *local* signs are the well-known redness, heat, pain, and swelling, to which may be added disturbance or alteration of function. Except in a typical case, these signs are not all necessarily present; on the other hand, the presence of one or more is not always indicative of inflammation.

The *redness* is due to the dilatation of the small arterioles, veins and capillaries, and increased flow of blood to the part; the darker patches over the general surface to the escape of red corpuscles, and to the blood passing into the veins before the oxyhæmoglobin has all been reduced. The redness varies according to the intensity of the inflammation, being bright in the acute, and dull in the chronic variety, and generally assumes a livid hue when suppuration is about to occur. It may sometimes be absent, as in inflammation of non-vascular tissues, although present in the vascular area around. It more or less disappears after death.

The increased *heat* is now generally held to be due merely to a greater flow of blood through the part, and not to any generation of heat in the part itself, as the blood coming from it is never hotter than the blood in the left ventricle of the heart. The inflamed part, however, feels intensely hot and burning to the patient, although the thermometer shows little actual increase of heat.

The *pain*, which is due to pressure upon or stretching of the terminal nerve-twigs by the dilated blood-vessels and by the exudation, varies in intensity and in character, and is nearly always increased by pressure and by the dependent position. It is of a stabbing character in serous membranes, aching in bone, throbbing when pus is about to form; more intense when occurring in organs where but slight stretching can occur, as the globe of the eye or the testicle; and less intense in parts like the axilla where the tissues are loose. In the eye, as well as pain there may be flashes of light; in the ear, noise. The pain is sometimes referred through the nerves to other parts or organs.

The *swelling*, which is caused partly by the increased quantity of blood in the inflamed area, partly by the exudation of leucocytes and serum, and partly by the proliferation of the original tissue elements, is, as might be expected, greatest in lax tissues, as the axilla, and least in the dense and fibrous, as bone or tendon. It is always an important sign in chronic inflammation where there may be but little redness or pain.

The *disturbance in function*, which practically always occurs in an inflamed part, may be illustrated by the inability of an inflamed bladder to retain urine, or of an inflamed eye to tolerate light.

The *constitutional symptoms* may be summed up as those of fever. There is a rise of temperature—often preceded by chilliness or even a distinct rigor, a quickened pulse, dry skin, furred tongue, loss of appetite, constipation, scanty and high-coloured urine, headache, perhaps delirium, and a general feeling of malaise. When the inflammation is slight there may be no fever; but when it is at all intense, or occurs in an important part, the fever is generally considerable, and in septic and infective inflammations is by far the most anxious symptom. Inflammatory fever has been divided into the sthenic, asthenic, and the irritative or nervous. In the *sthenic* the symptoms are acute, the temperature is high (104° or 105°), and the pulse full, strong, and bounding. In the *asthenic* the symptoms assume what is called a typhoid character; the temperature falls, the tongue becomes brown and dry, the lips and teeth are covered with sordes, and the pulse is quick, soft, and feeble. In the *irritative* there is, in addition to either of the above set of symptoms, delirium, violent in the one case, or low and muttering in the other, and a general nervous state.

The *cause* of the fever has been variously explained. In simple inflammation it may be due: 1, in part to tissue-change caused by the presence in the blood of some products of digestion as albuminoses or peptones (substances known to possess pyrogenic or fever-producing properties), which are supposed to be derived from the action of the leucocytes on the proteids of the tissues and to be drained away in the serum from the inflamed part by the lymphatics; and, 2, in part, although this is very doubtful, to disturbance of the heat-regulating centre in the brain, induced either reflexly, through the sensory nerves, as when there is much pain and tension in the inflamed part, or directly, by the action on it of the deteriorated blood. In septic inflammations the absorption of the products of fermentation or putrefaction, as from a septic or ill-drained wound, has no doubt a large share in the production of the fever, which is then spoken of as septic (*septic fever*, *sapræmia*); whilst in the infective inflammations the toxins of micro-organisms are believed to be the chief factor (see *Septicæmia* and *Pyæmia*).

VARIETIES OF INFLAMMATION.—Inflammation may be divided into the *acute* and *chronic* according to its intensity and duration; the acute again into the *simple*, the *septic*, and the *infective*. What has already been said applies chiefly to the acute variety. The chronic is discussed separately later on.

Simple or traumatic inflammation is that which remains localized to a limited area, and subsides without suppuration as soon as the cause is removed. It is commonly the result of a mechanical injury, and may be studied in its simplest form in the healing of an incised wound by the first intention (see *Wounds*). Should suppuration occur it is generally due to the presence of certain pyogenic micro-organisms (see *Suppuration*, p. 20).

Septic inflammation depends upon fermentation or putrefaction in a wound or serous cavity set up by the presence of saprophytic bacteria; it spreads beyond the original seat of injury, and is accompanied by constitutional symptoms of blood-poisoning (*septic fever, sapræmia*). The septic products soak into the tissues, where they act like other chemical irritants, and so set up wider and wider circles of inflammation, and entering the general blood-stream with the serum which is drained away by the lymphatics, give rise to septic poisoning. They do not multiply in the living tissues, like the micro-organisms producing the infective inflammation to be next described. Hence as soon as the fermentation or putrefaction can be checked the spreading of the inflammation and septic poisoning have a tendency to cease. Septic inflammation is often accompanied by suppuration, but this is regarded as a complication depending on the presence of pyogenic micro-organisms (see *Suppuration*). Some surgeons include under the term *septic* all inflammations attended by suppuration and the various specific inflammations, as erysipelas, which are here called infective.

The *infective* variety is also of a spreading character, and depends upon the presence of special micro-organisms (*pathogenic bacteria*). Unlike the products of putrefaction these micro-organisms multiply and thrive in the living tissues and in the blood-stream. They may also under certain circumstances become lodged in the lymphatic glands and in the capillaries of distant tissues and organs, where they give rise to inflammations similar to that at the seat of primary inoculation. Like the septic, the infective inflammations are generally accompanied by severe constitutional symptoms. The micro-organisms may enter, it is thought, either through a wound, or through the respiratory or alimentary tract; and though not essential, a septic wound favours their admission. (See *Infective processes in wounds.*)

It must be remembered that whether an inflammation is *septic* or *infective*, in both cases the lesions and symptoms are due (*a*) to the presence of bacteria, and (*b*) to intoxication, the only difference being that in one case the bacteria are saprophytic and in the other parasitic.

Inflammation also admits of other divisions; thus it is variously spoken of as traumatic, idiopathic, strumous, syphilitic, gouty, &c., according to its supposed cause; as adhesive, suppurative, and ulcerative, according to its termination, &c.

THE TREATMENT of inflammation may be divided into the *Preventive* and the *Curative*. The former will be discussed under the *Treatment of wounds.*

Curative treatment.—This must necessarily vary according to the character and situation of the inflammation and the type of constitutional disturbance. Here only are given the indications which should guide us in the general management of the case. Our *first* endeavour where practicable should be to remove the cause. Thus a foreign body in the tissues, such as a thorn in the finger, should be extracted; tension should be relieved; a free drain established for any pent-up and decomposing discharges; exit given to extravasated secretions, as putrid urine and the like; bacterial activity as far as possible minimized or prevented by antiseptics and antitoxins; irritating applications, as strong antiseptics, exchanged for less irritating dressings; and such constitutional causes as syphilis, gout, &c., treated by appropriate remedies. When the cause can be thus removed and fresh sources of irritation avoided, the inflammation will tend of itself to cease. Where such cannot be done, we should in the *second* place endeavour to prevent the complete loss of vitality of the already injured tissues and to restore their healthy nutrition. For this purpose our efforts should be principally directed to controlling the supply of blood to the part, and reducing the blood-pressure in the damaged blood-vessels in order to lessen the escape of leucocytes and serum, the pressure of which on the vessels and tissues may lead to the death of the part, whilst the tension to which they give rise is a fertile source of fresh irritation and consequently of the continuance of the inflammation. Further, we should aim at counteracting this injurious pressure and tension by facilitating the draining away of the products of inflammation; whilst we should seek to promote the return of healthy nutrition to the inflamed tissues by endeavouring to remedy such constitutional defects which, as we have seen, by lowering their vitality act as predisposing causes. *Thirdly*, we should not lose sight of the important indication to relieve pain. And *lastly*, whilst directing our efforts to the treatment of the local inflammation, we must modify our remedies according to the type of constitutional disturbance to which it may give rise.

General remedies.—The means at our disposal for fulfilling the above indications are both local and constitutional. In some cases local remedies alone will suffice; in others constitutional remedies will also be required.

(A) *The local* may be enumerated as rest, elevation of the part, cold, heat and moisture, local blood-letting, incisions, and astringents. These means should not be used indiscriminately; those that may at one period be of the greatest benefit, may at another produce the result we are trying to avoid.

Rest is one of the most important means we possess in the treatment of surgical inflammation. It should be complete, and as far as possible both functional and physiological. Thus, an inflamed joint should be placed on a splint, an inflamed eye receive no light, &c.

Elevation of the part relieves swelling and tension by diminishing the arterial supply, and by promoting the venous return, and the draining off by the lymphatics of the inflammatory exudation. Thus, an inflamed hand should be placed in a sling, an inflamed foot raised on a pillow, &c.

Cold, though a most powerful agent in controlling inflammation, is one that requires cautious and seasonable application. It acts by causing contraction of the small arteries, and consequently diminishes the supply of blood to the part; it likewise controls the amœboid movements of the leucocytes. At the same time when intense it lowers the vitality of the tissues and promotes adhesion of the corpuscles and stasis, and as exemplified by frost-bite may destroy the part. It is of the most service in the preventive treatment of inflammation, and for controlling the process in the early stages. Later, when the inflammation is fully established, it can only do mischief. Its action should be continuous; if applied intermittently it tends to increase the inflammation by the reaction which follows each application. It is best applied in the form of an ice-bag, or by irrigation with ice-cold water, or by Leiter's tubes.

Heat and moisture act by causing a general dilatation of the capillaries and free flow of blood through the part. They are especially useful when the inflammation has become fully established, and suppuration is threatened. Under the latter circumstances they tend to localize the process, and bring the abscess to the surface. They may be applied in the form of boracic poultices or hot fomentations, to which opium and belladonna in some form may be added to soothe and relieve pain. The boracic poultice is made by soaking cotton-wool or lint in a boiling saturated solution of boric acid, or of boroglyceride (ʒj to Oj). The material is then wrung out, applied to the part, and covered by gutta-percha tissue, or oil silk. Heat alone may be applied by means of Leiter's tubes, the water being kept heated by Krohne's lamp.

Local blood-letting relieves the vessels of the inflamed part, and so removes tension. It may be employed in the form of leeches, wet-cupping, or incisions with a lancet. It is often of great benefit, even when not applied directly over the part, as is shown by the relief afforded to an inflamed eye by a leech behind the ear.

Incisions are useful in some forms of inflammation, as phlegmonous erysipelas, to relieve tension. They should be made in the long axis of the limb, care being taken to avoid important structures.

Astringents act by constricting the blood-vessels, and are especially useful in inflammations of the mucous membrane of the mouth, nose, urethra, and conjunctiva.

(B) *Constitutional remedies*, like the local, should be used according to the intensity, nature and situation of the inflammation, and the type of the constitutional disturbance. In an ordinary case of simple inflammation, beyond a brisk purge, subsequent regulation of the bowels and secretions by salines, and restricting the diet, no special constitutional treatment is required. But when the fever is high, the patient young and vigorous, and the pulse rapid, full, and strong—in short, where the fever is of the sthenic type, antiphlogistic or lowering treatment should be adopted. Where, on the other hand, the patient is weakly or old, or broken down in constitution, and the fever is of a low or asthenic type, a stimulating plan of treatment will be required.

Antiphlogistic treatment may be considered under the heads of diet, drugs, and general blood-letting.

The *diet* should be restricted to milk, weak beef-tea, barley-water, arrowroot, and the like.

Drugs.—Purgatives determine the flow of blood to the intestines, and so relieve the inflamed part. They are not, however, generally employed except as a brisk purge at the onset of the inflammation, and in gonorrhœa and orchitis, in which they are of considerable benefit. In inflammations of the intestine they should not as a rule be used at all. Diaphoretics and diuretics relieve the distended vessels, the former by determining the flow of blood to the skin, the latter to the kidneys. They are not often employed in surgical inflammations. Aconite in small doses, frequently repeated, is believed to reduce the frequency and force of the heart's action, and is much praised by some. Antimony was formerly much employed, and is still used in inflamed testicle. Mercury in combination with opium was once in much favour, and was thought to have a controlling action on the inflammation. It is seldom given at the present day, except in syphilitic inflammation, and as a purgative at the commencement of other inflammations. Opium, however, is frequently used to relieve pain, and it also seems to have some action in controlling the inflammation. It may be given by the mouth, or in the form of morphia as a subcutaneous injection. Quinine, salicylic acid, and antipyrin are sometimes employed when the temperature is high, as is colchicum in gout, potash and salicylate of soda in rheumatism, perchloride of iron in erysipelas, and hyoscyamus, bromide of potassium, sulphonal, and chloral when there is want of sleep.

Bleeding is not often employed in modern surgery, but it is at times beneficial in very acute inflammations in young and plethoric subjects. Of late bleeding has again become not so very uncommon in the medical wards. The surgeon should therefore make himself acquainted with the method of operating. The blood may be taken from one of the veins of the arm, usually the median basilic, as that is the larger vessel, or from the external jugular vein. In bleeding from a vein of the arm (*phlebotomy*), a bandage or tape is carried twice round the arm a little above the elbow to obstruct the vein and tied in a bow. Grasping the arm with the left hand, with the thumb steadying the vein, the surgeon makes an incision into the vessel, holding the lancet with the blade between his forefinger and thumb about half an inch from the point, to prevent it penetrating too deeply (Fig. 2). The blood is directed into a graduated bleeding-bowl, the flow if necessary being increased by the patient making his muscles act by grasping a stick. When sufficient blood has been taken (usually about 10 oz.) the constricting tape is untied, a pad placed over the incision, and the ends of the tape carried across the pad to below the joint, then round the arm and again over the pad, where they are tied.

The *stimulating plan* of treatment may be considered under the heads of diet, drugs, and stimulants. The *diet* should consist of essence of beef, milk, eggs, milk-puddings, oysters, turtle soup, and of white fish and minced chops if solid food can be retained.

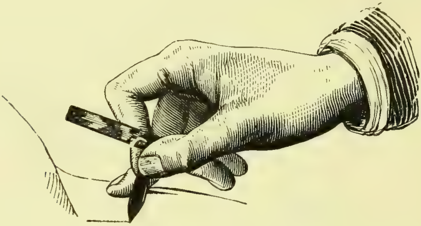

Fig. 2.—Method of holding the lancet in bleeding. (Heath's Minor Surgery.)

Of *drugs*, ammonia and bark, or quinine and iron will generally be found of most service; whilst *stimulants* in the form of brandy, the brandy-and-egg mixture, port-wine, champagne, or any other that the patient has been accustomed to take, should be given in divided and measured doses at stated intervals. Stimulants increase the force of the heart's action, and so drive the blood through the inflamed part, and maintain the circulation till the crisis has been tided over. The indications for their use are a feeble and frequent pulse, a high temperature, a dry and brown tongue, and general signs of prostration.

CHRONIC INFLAMMATION.

The pathological process in chronic inflammation is essentially the same as in the acute; but the dilated vessels appear to lose their tone, and remain dilated for longer periods, and the escape of leucocytes and proliferation of the original tissue elements are continuous. Further, the inflammatory exudation contains less fibrin-forming material and albumen. Like the acute, it may terminate in resolution, suppuration or ulceration, but it is much more liable to produce chronic thickening, from the accumulation of the cellular elements in the tissues. It may also terminate in caseation, or even calcification.

The causes of chronic inflammation are similar to those of the acute, but they appear to act with less intensity and for longer periods. Amongst the predisposing causes must be especially mentioned passive congestion, struma, rheumatism, gout and syphilis. The exciting causes are very often slight, and may be altogether overlooked; whilst secondary causes which may keep up the inflammation for an almost indefinite time frequently come into play. Thus in chronic joint-disease, though the cause may be but a trivial injury in a rheumatic subject, continual movement, and tension due to the distension of the synovial membrane, may keep up the inflammation for months or years. The presence of miliary tubercle is a frequent exciting cause.

Symptoms.—These are also local and constitutional. Of the local signs the redness may be absent, or, if present, may be of a dusky hue, whilst the part is often discoloured from pigmentation due to the disintegration of the coloured corpuscles. The pain is less severe than in the acute, often of a dull aching character, and increased on pressure, and sometimes worse at night. The part may be slightly hotter than natural, but at times no increased heat is apparent. Swelling is always a marked sign. Constitutional symptoms may be altogether absent; generally, however, the patient's health is feeble or below par, or he is strumous, or he has gouty, rheumatic, or syphilitic symptoms. At times there may be some fever when an important organ is affected.

Treatment.—The indications are:—to remove the cause and all secondary sources of irritation; to promote the absorption of the inflammatory products; and to re-establish the normal nutrition of the damaged tissues. For this purpose constitutional as well as local means should be employed. Thus:—we should endeavour to improve the general health by a careful dietary and the regulation of the secretions; whilst stimulants and tonics should be given where indicated. In the strumous, cod-liver oil, in the syphilitic, mercury or iodide of potassium, in the gouty, colchicum, and in the rheumatic, the salts of potash or guaiacum, are especially indicated; whilst residence at the seaside, or at some spa, suitable to the diathesis, or a sea voyage should be enjoined. Locally, the means at our command, besides rest of the part, are: 1, *counter-irritation* by blisters, tincture of iodine, and stimulating liniments; 2, *friction* with mercurial ointment, the oleate of mercury or ointments of iodide of lead or cadmium, or by shampooing, massage, &c.; 3, *pressure* by means of carefully-applied bandages, Scott's dressing, or Martin's bandage, or the ammoniacum and mercury plaster; 4, the formation of *setons* or *issues;* and 5, the application of the *actual cautery.* Where suppuration threatens, as in chronic inflammation of lymphatic glands, sulphide of calcium may be of service in promoting the rapid breaking down of the caseating mass. It should be given in doses of $\frac{1}{6}$ to $\frac{1}{3}$ of a grain.

SUPPURATION AND ABSCESS.

We have already seen that under some circumstances the inflammatory process may terminate in the softening and breaking down of the inflamed tissues, infiltration of leucocytes and proliferation of tissue-cells, and consequent formation of pus, suppuration being then said to be established. This process, whether it occur (1) in the substance of the tissues or organs, or (2) on the free surface of the skin, a mucous or a serous membrane, is practically the same. In the former case, it is spoken of as circumscribed or as diffused suppuration, according as it is limited in extent or the reverse; in the latter case it is known as purulent exudation or catarrh, or as ulceration, according as the process merely involves the superficial layers of the epithelium, or extends through to the deeper parts. We will first deal with the circumscribed variety of suppuration, or *abscess*, as this is the most familiar example to surgeons.

Circumscribed suppuration or abscess.—An abscess may be defined as a circumscribed collection of pus, the result of inflammation. It may be acute or chronic.

Acute abscess.—The formation of an abscess may perhaps best be studied as it occurs in the superficial tissues. We have already seen that an inflamed part is hot, red, swollen, and painful. If the inflammation ends in suppuration, the swelling which was more or less diffuse becomes circumscribed and pronounced, the redness localized and more intense, the pain assumes a throbbing character, and a distinct chill or rigor is generally experienced. On pressing lightly with the fingers on the inflamed part a sensation of fluid beneath the skin is felt, and *fluctuation* is said to be present. If left to nature the abscess makes its way in the direction of least resistance, *i.e.*, generally towards the free surface of the skin, or if more deeply seated, towards a mucous canal, serous cavity, or the interior of a joint. Continuing to take a superficial abscess as our example, one part of the inflamed area becomes more prominent than the rest, and the skin over it red and glazed. The abscess is said to *point.* The skin will shortly ulcerate or slough, and bursting of the abscess with discharge of the pus will ensue. On the evacuation of the pus either naturally as above, or through an incision artificially made, the walls fall more or less together, and the cavity is gradually filled up by granulations till finally only a scar remains. The *minute changes* concerned in this process are briefly as follows:—The leucocytes which have escaped from the vessels in the way already described, together with the round cells resulting from the proliferation of the original tissue elements, aggregate at the focus of inflammation around the micro-organisms, which, if not already present as the cause of the inflammation, have now made their way to the inflamed spot. The tissues, as the result of the devitalizing action of the products of the micro-organisms, undergo what is called coagulation-necrosis, and then softening and liquefaction, and finally disappear among, or are absorbed by, the leucocytes and proliferated tissue-cells which now completely replace them in the form of a mass of small round cells. Some of the cells in the centre of this dense mass being cut off from their nutrient supply by the destruction of the vessels, partly as the result of over-stimulation or over-work in their battle with the micro-organisms, and partly as the result of the action of the metabolic products of the latter, in their turn degenerate and die, and are now found suspended in a fluid formed by the liquefied tissues and serous exudation infiltrating the part.

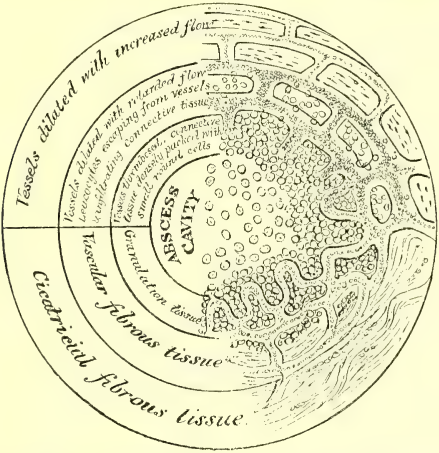
Vessels dilated with increased flow
Vessels dilated with retarded flow
Leucocytes escaping from vessels
& infiltrating connective tissue
Vessels thrombosed, connective
tissue densely packed with
small round cells
ABSCESS CAVITY
Granulation tissue
Vascular fibrous tissue
Cicatricial fibrous tissue

FIG. 3.—Diagrammatic representation of the minute changes in the formation and healing of an abscess. The upper half shows abscess enlarging; the lower half abscess healing.

The leucocytes and round cells derived from the fixed connective-tissue cells are known as *pus corpuscles*, the fluid as *liquor puris*. Thus a cavity is formed containing pus. Meanwhile around the cavity the leucocytes and tissue-cells continue to aggregate and thus form a barrier to the advance of the microbes. New vessels now grow into the mass of small round cells and the abscess cavity becomes surrounded by a layer of vascular granulation-tissue (*the pyogenic zone*). The accompanying woodcut (Fig. 3) illustrates diagrammatically the appearance that would be presented by a section through an abscess and the surrounding tissues. In the centre is the abscess cavity; around this in the upper half of the diagram are zones representing the inflammatory changes in various stages of progress. When an abscess enlarges it is simply by the extension of the inflammatory process from zone to zone. The central cavity (Fig. 3) increases by the successive degeneration of the small round cells, which fall into the cavity and become pus corpuscles, whilst what was formerly the zone of thrombosis is now converted by the aggregation of the leucocytes and proliferated tissue cells into the zone of small round cells, the zone of dilated vessels and retarded flow into the zone of thrombosis, and so on to the circumference. Such at least occurs when an abscess spreads uniformly in all directions. Usually, however, it makes its way in the direction of least resistance, these changes then occurring chiefly at that part. If an abscess is not opened the tension and the presence of the pus keep up the inflammation, but when the pus is evacuated and all sources of irritation are removed the circulation in the vessels around resumes its normal state. The walls in consequence of the pressure of the surrounding tissues fall more or less into contact, and what remains of the cavity is gradually filled up by the growth of the granulation-tissue. The granulation-tissue is developed into fibrous tissue, which in its turn contracts, obliterating the blood-vessels, and is converted into dense cicatricial tissue. In the lower half of the diagram (Fig. 3) are zones representing the various changes in the process of healing.

Characters of pus.—Pus from an acute abscess in an otherwise healthy person is a thick, creamy, opaque, yellowish-white, slightly alkaline fluid, with a faintish smell, saltish taste, and a specific gravity of about 1030. If a drop is examined under the microscope it is found to consist of a fluid (the liquor puris) and corpuscles (pus cells). Some of these corpuscles are globular, slightly granular, and measure $\frac{1}{2400}$ of an inch in diameter, whilst some contain two or three nuclei, which are made more evident on the addition of acetic acid to clear up the granular matter. Amongst them may be seen other corpuscles indistinguishable from leucocytes, and exhibiting when examined on a warm stage amœboid movements. The latter are living leucocytes and tissue cells, the former leucocytes and proliferated tissue cells which have undergone death and degeneration. The proportion of dead to living pus cells varies with the duration of the inflammation. The liquor puris consists of water, albumen, and salts, of which chloride of sodium is the chief. It coagulates on boiling. Though probably derived in chief part from the exudation of the plasma through the vessels, it differs from plasma in that it does not generally coagulate spontaneously. In acute abscesses the pus contains granular material derived from the rapid degeneration of the tissues and various species of micro-organisms, usually cocci. If allowed to stand or to decompose in an imperfectly drained abscess cavity, it will be found moreover teeming with the bacteria of putrefaction.

Varieties of pus.—Pus is variously spoken of as *sanious* when it contains blood, *curdy* when portions of coagulated fibrin are seen floating in it, *ichorous* when of a watery consistency, *muco-pus* when mixed with mucus, and *infective* when containing pathogenic micro-organisms. It some instances it has been observed to have a bluish-green colour (blue pus), due to the presence of the *Bacillus pyocyaneus.*

The *Cause* of inflammation terminating in an acute abscess may briefly be said to be the presence of micro-organisms in tissues whose vitality has been lowered by the persistent action of an irritant or by the debilitated condition of the patient.

The micro-organisms which are commonly found in processes of suppuration are called *pyogenic.* The commoner forms are the following: The *Staphylococcus pyogenes aureus*, the *Staphylococcus pyogenes albus*, to which must be added the *Staphylococcus citreus ;* 7
the *Streptococcus pyogenes* and the *Streptococcus erysipelatosus*, probably identical forms; the *Pneumococcus*, frequently found in otitis, and the *Gonococcus.* Of these the gonococcus produces a specific form of suppuration, but the others are the organisms of primary suppuration, as distinguished from a suppuration occurring during the course of or after an infective fever, such as typhoid fever or measles. In such secondary forms of suppuration generally, it seems, the ordinary pyogenic organisms are found, but frequently in or after typhoid fever at least the typhoid bacillus occurs at the seat of suppuration, and then as a rule combined with one or other of the true pyogenic organisms. In pus, streptococci alone or staphylococci alone may be observed, but generally mixtures of organisms. It is impossible to distinguish various kinds of pus or various forms of suppurative processes according to the bacterial flora. Many bacilli are often associated with these pyogenic cocci, but they must be regarded as contaminations rather than as being of primary importance. Amongst these may be mentioned the *Bacillus coli communis* and the *Bacillus pyocyaneus* (the cause of the

characteristic colour of blue pus), and the putrefactive bacilli of stinking pus. Although the above-mentioned cocci are called pyogenic on account of their presence in pus, it must not be forgotten that pus formation is not a specific property with them, but that, excepting perhaps the gonococcus, any one of them is capable of causing one of the following lesions: (1) local inflammation, (2) cellulitis, (3) acute suppuration, (4) acute gangrene, (5) septicæmia and pyæmia, and (6) infective endocarditis. They are the organisms of general inflammation, and the present state of knowledge does not allow of a diagnosis between processes produced by one or other of them.

The *Staphylococcus pyogenes aureus* and *albus* are found in inflammations running on to suppuration and abscess. The organisms are found gathered in grape-like (Fig. 4) masses, and the growth in an artificial culture is golden-coloured or white, according to the variety present. Sometimes another coccus, yielding a lemon-coloured growth, is found, the *Staphylococcus citreus*. The *Staphylococcus aureus* occurs in suppurating wounds, in pustular inflammations of the skin, in suppuration in bone, in suppurating joints, in acute periostitis and osteomyelitis, in purulent peritonitis, and in empyema and other deep abscesses. The *Staphylococcus albus* is often associated with other pyogenic cocci, especially in inflammations involving the skin, and occurs most frequently in the same class of cases as the *Staphylococcus aureus*, but is supposed to be less virulent. These organisms may extend from a wound either by the lymphatics or by the veins, and give rise to metastatic abscesses (pyæmia), or they may enter the system through ulcers of the respiratory or digestive tract. The exact point of entry in acute periostitis and osteomyelitis, ulcerative endocarditis and empyema is uncertain.

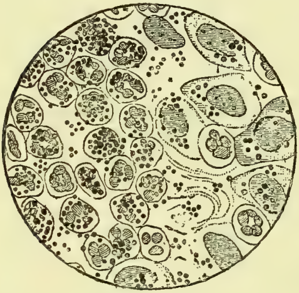

Fig. 4.—Staphylococci. × 950. (After Sternberg.)

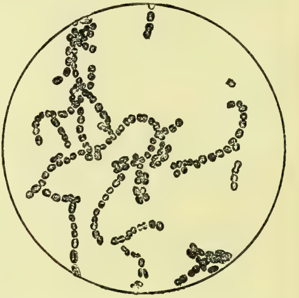

Fig. 5.—Streptococci. × 1000. (After Sternberg.)

The *Streptococcus pyogenes* is frequently found in suppurations attended by phlegmonous or purulent œdema with a tendency to spread. The organisms occur in chains (Fig. 5). The suppurations in which they appear to be chiefly concerned may start in a septic wound of the skin, or the puerperal uterus, or on a mucous or serous surface in contact with infected tissues. Absorption of the chemical products produced by these organisms is very liable to occur, giving rise to general blood-poisoning, or if the micro-organisms themselves also gain access to the circulation they may become lodged in the capillaries and produce metastatic abscesses, so that the toxic symptoms produced by the absorption of the chemical products may be accompanied by metastatic (*pyæmic*) abscesses. Pyæmia and septicæmia are, however, almost as frequently caused by the *Staphylococcus aureus* or *albus*.

The *Streptococcus erysipelatosus*, which is closely allied to the *Streptococcus pyogenes*, and the *Micrococcus gonorrhœæ*, are referred to under Erysipelas and Gonorrhœa.

The *Symptoms* of an acute abscess are at first those of inflammation, followed, whilst pus is forming, by a chill or rigor and by throbbing pain in the part. The pain, however, usually ceases when suppuration is fully established. The local signs, when the abscess is superficial, are pointing, central softening, and when about to burst, a red and glazed appearance of the skin with separation of the cuticle. Deep suppuration is often difficult to detect ; deep-seated fluctuation, œdema, subcuticular mottling and tenderness on pressure are then the chief signs ; but puncture with an exploring needle will clear up any doubt.

Treatment.—The chief indications are to remove the pus with as little injury to the tissues as possible, to ensure an efficient drain, and to maintain the parts aseptic. When it is evident that suppuration must ensue it should be promoted by moist warmth in the form of a large boracic poultice sprinkled with opium, or hot poppy fomentations. As soon as fluctuation is detected the abscess should be opened by making a free incision in the most dependent part or where it is pointing, of course taking care to avoid blood-vessels or other important structures in the neighbourhood. The pus should generally be allowed to flow out of its own accord. To ensure a thorough drain, and to prevent any tension from re-accumulation, the opening should be free and a drainage-tube should be inserted. If the abscess is large a counter-opening may be necessary or the abscess cavity may degenerate into a sinus. Where recesses or pouches exist the septa between them should be broken down with the finger introduced into the abscess cavity. After the pus has been let out an absorbent antiseptic dressing or boracic poultice should be applied. Although it is a rule in Surgery to open an abscess as soon as fluctuation clearly shows that pus has formed, there are some instances in which this is especially imperative. Thus an abscess should be opened at once when it is situated in the perineum, the abdominal or thoracic walls, the sheath of a tendon, under deep fasciæ or the peritoneum, in the orbit, near a joint, and in the neck if attended by dyspnœa; when obstructing some passage; when caused by the infiltration of urine, fæces, &c.; and when a spontaneous opening would produce deformity.

Hilton's method, as it is called, of opening an abscess, is very useful when the abscess is situated deeply and amongst important structures, as at the root of the neck or in the axilla. It consists in making an incision through the skin and fascia, and then working gently in the direction of the pus with a director. As soon as pus presents, a pair of dressing-forceps is slid along the groove of the director into the abscess cavity, the director removed, and the blades of the forceps separated so as to stretch the opening and make a free exit for the pus.

The complications of acute abscess are: 1. Hæmorrhage from the involvement of a large vessel. 2. The implication of some important part, as the peritoneal cavity, the interior of a joint, &c. 3. Degeneration into a sinus or fistula. 4. Blood-poisoning (*sapræmia*, *septicæmia*, and *pyæmia*).

A *chronic abscess* differs from an acute in that it is formed slowly, is unattended by the ordinary signs of inflammation, and, although generally caused by bacteria, does not necessarily depend upon the presence of the pyogenic micrococci. The contents, moreover, are usually thin and curdy, not thick and creamy like the pus from an acute abscess. In some situations, however, as in the chronic abscess in the subcutaneous tissue so familiar to the surgeon, the contents may differ very little to the naked eye from ordinary pus, and, when the result of tuberculous disease, may contain the tubercle bacillus. A chronic abscess is generally formed in connection with carious bone, joint-disease, a caseating lymphatic gland, or tuberculous deposit. At times no cause can be discovered. *When due to spinal caries* a chronic abscess has a tendency to burrow in the tissues, especially in the long axis of the body; and its walls often become condensed and thickened, and lined with a layer of smooth granulations, which give it a velvety and mucous membrane-like appearance, or they may become coated with a thick layer of caseating tuberculous matter. *The symptoms* are very various, and differ according as the abscess is found in connection with carious bone, a diseased spine, &c., and will be again referred to under the head of Suppuration in Bone, Psoas abscess, &c. Here it may be stated generally that the chief signs are a fluctuating swelling, often unattended with any sign of inflammation, and the presence of some affection, as spinal caries, that is known to be often associated with abscess. Before a chronic abscess is opened there are usually no constitutional symptoms; but subsequently saprophytic bacteria or pyogenic micrococci may gain admission, and long-continued suppuration attended by hectic fever or lardaceous disease of the viscera is very liable to ensue and terminate fatally from exhaustion, renal disease, diarrhœa, or hepatic mischief. *Diagnosis.*—A small chronic abscess in the subcutaneous tissue may be mistaken for a fatty tumour, an hydatid or other cyst, a blood-extravasation, or a soft solid tumour, and it may be quite impossible to arrive at a correct diagnosis without puncture with a grooved needle. The diagnosis of chronic abscess connected with the spine, joints, &c., will be further alluded to in the section on Diseases of Regions. *Terminations.*—A chronic abscess, after remaining quiescent for a long period, may take on increased action, and burst either externally, or into a mucous canal, a serous cavity, &c., or the watery portions of the pus may be absorbed, leaving behind a caseous mass, which may either dry up or undergo calcification; or it may remain in its caseous state for years, and then break down, and set up fresh inflammation around, and produce what is called a *residual abscess*. *Treatment.*—Small chronic abscesses unconnected with diseased bone, joints, &c., should be dissected out, or if this is impracticable freely incised and then scraped and sewn up or drained antiseptically. Large abscesses, especially when the result of spinal disease, require very careful management. If antiseptic precautions are neglected, and the pus is allowed to undergo putrefaction or fermentation, or pyogenic cocci gain admission, long-continued suppuration and attendant hectic generally follow and frequently terminate fatally. The best plan would appear to be to aspirate the abscess frequently so as to reduce its size, injecting at each aspiration iodoform emulsion, and then to open it with antiseptic precautions, scrape out the tuberculous material lining it with a Volkmann spoon, well rub the walls with aseptic sponges on long forceps, irrigate with a weak antiseptic, throw in some iodoform emulsion, and close the wound. Should the abscess refill, this process may be repeated or an antiseptic drain established. Aspiration alone, however, and especially when combined with the injection of iodoform emulsion, will in some cases suffice, the abscess drying up, and in this way becoming cured.

Diffuse suppuration may occur either: 1, in the substance of the tissues or organs; or, 2, on the surface of the skin or a mucous or serous membrane. As examples of the former may be cited cellular and cellulo-cutaneous erysipelas, in which, as the result of a spreading infective inflammation, extensive suppuration occurs through large tracts of the subcutaneous tissue; as examples of the latter, gonorrhœa, bronchitis, and some forms of peritonitis. The pathological process in both is practically similar, only that in one the inflammatory products (pus) are diffused through the tissues, and in the other over the free surface. Suppuration on the free surface of the skin or mucous membrane when the deeper layers of these structures are involved, is, however, spoken of generally as ulceration; and when the epithelial layers only are affected, as intertrigo in the case of the skin, and as purulent catarrh or pyorrhœa in the case of a mucous membrane.

Constitutional effects of long-continued suppuration. Hectic fever and lardaceous disease.—HECTIC FEVER is a common accompaniment of prolonged suppuration from whatever cause when the wound cannot be kept aseptic and efficiently drained. It has been ascribed to the drain on the system owing to the formation of large quantities of pus; but this is certainly not the only cause, as a chronic abscess may attain a very large size, and exist for years unattended by hectic as long as it remains unopened; nor after opening does hectic occur if the pus can be prevented from undergoing fermentative or putrefactive changes, and the cavity can be well drained. It would therefore rather appear to be due to a chronic blood-poisoning, consequent upon the absorption of the products of fermentation or putrefaction in small quantities at a time. *Symptoms.*—Hectic fever is characterized by profuse sweating, rapid wasting, nocturnal rises of temperature with morning remissions, and generally by diarrhœa and deposits of urates in the urine. The face is pale and pinched, the cheek flushed, the eye bright, the pupil dilated, the tongue red and dry at the edges, and the pulse rapid, small and weak. The appetite gradually fails, the patient becomes weaker and weaker, and dies exhausted of diarrhœa, lardaceous disease, &c. *Treatment.*—The cause of the suppuration should be removed, or, if this is impossible, the absorption of septic products should be as far as is practicable controlled by establishing a free drain to the suppurating cavity, and by preventing the putrefaction of the discharges by the use of antiseptics. At the same time the system must be supported by nourishing diet and stimulants, the sweating combated by dilute sulphuric acid or atropine, and the diarrhœa by opium, catechu, or other astringents.

LARDACEOUS DISEASE is another of the complications that may follow prolonged suppuration consequent upon long-standing disease of the bones or joints. As the disease, however, perhaps falls more often under the notice of the physician than of the surgeon, the student, for a description of it, is referred to a work on Medicine.

SINUS AND FISTULA.

When an abscess opens spontaneously, or is opened artificially, we have seen that the cavity usually fills up with granulations. Under some circumstances, however, as when an abscess is connected with tuberculous caries or with dead bone, or contains a foreign body, or is formed in connection with a mucous canal or secreting gland, or its walls after opening are prevented from remaining in contact by muscular action, the abscess does not close, but degenerates into a suppurating track called a 'sinus' or 'fistula.' Though the terms 'sinus' and 'fistula' are often used synonymously, the former is generally applied to such a track when it is only open at one end, the latter when it is open at both ends. Although, perhaps, a sinus or a fistula more often owes its origin to the non-closure of an abscess, and is hence described here, it may also be the result of a wound, of ulceration, of sloughing, or of a congenital defect. Special forms of fistulæ, as fistula in ano, recto-vesical fistula, salivary fistula, &c., will receive special notice under Diseases of Organs. Here generally it may be said that a sinus, and in some instances a fistula, is a long and often tortuous suppurating track, lined with a smooth membrane, and usually opening in the midst of prominent granulations. *Treatment.*—The cause should be sought, and if possible removed, and the walls of the sinus then scraped and pressed together by careful bandaging. The bandage should be so applied as to prevent the accumulation of pus in the deeper end, and the consequent re-conversion of the sinus into an abscess. If this is found impracticable, a drainage-tube should be inserted and shortened daily as the sinus gradually fills up from the bottom. When the sinus has existed long, and the walls are callous and indurated, it should be stimulated by injections of tincture of iodine, nitrate of silver, or the like. Or the lining membrane when tuberculous may be scraped with a Volkmann's spoon or be destroyed by chloride of zinc, the galvano-cautery wire, or the benzoline or actual cautery. These and such-like means failing, the sinus should be laid freely open, the lining membrane cut or scraped away, and the wound plugged with iodoform gauze or other antiseptic material to ensure healing from the bottom. Where the laying open of a sinus would involve important structures, as a large vessel, or necessitate an extensive wound, or is otherwise impracticable or unadvisable, a counter-opening should be made by cutting on the end of a long probe, and the sinus then drained by passing a drainage-tube at first through it, and subsequently in at each end, and gradually withdrawing the two portions as the sinus heals. At the same time that these local means are adopted, attention must be paid to the general health, as the intractability of a sinus may depend in part, or even entirely, upon some constitutional derangement. The treatment of special fistulæ is elsewhere described. (See *fistula in ano, &c.*)

ULCERATION AND ULCERS.

ULCERATION is another of the terminations of inflammation, and as we have already seen, merely differs from suppuration in that the one occurs in the substance of the tissues, the other on the free surface. In both there is minute disintegration and liquefaction of the tissues, with infiltration of leucocytes and proliferation of tissue-cells and degeneration and death of some of the infiltrating leucocytes and proliferated tissue-cells; in suppuration, however, the infiltrating and proliferating cells being unable to escape form an abscess, whilst in ulceration the broken-down tissues and pus are cast off as soon as formed as a discharge or ichor. An abscess may therefore be said to be a closed ulcer, an ulcer an open abscess. This molecular death of the tissues serves to distinguish ulceration from gangrene, in which the tissues die *en masse* and are cast off in the form of a slough. The two processes, however, are frequently combined. The softening and breaking down of a new growth, though not generally due to inflammation, is also spoken of as ulceration. Ulceration may occur in any tissue of the body. Here, however, our description will chiefly apply to the process as it affects the skin or mucous membrane. Let us first study the process as it may be followed with the naked eye in a portion of inflamed skin. The cuticle in the centre of the inflamed spot separates or is rubbed off, and a raw surface is thus left which gradually enlarges in depth and extent, leaving an angry-looking sore exuding a sanious discharge. Supposing the destructive process to now cease, minute red points called 'granulations' spring up from the surface of the sore, and the discharge is replaced by pus. The ulcer skins over from the margins, till the raw surface is thus covered in, and finally a *scar* only is left to mark the situation of the former wound.

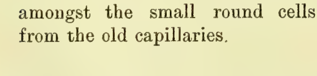

FIG. 6. — Diagram of ulceration. Formation of granulation-tissue. New capillaries growing out amongst the small round cells from the old capillaries.

The minute changes are as follows:—The tissues at the focus of inflammation where stasis has already occurred become infiltrated with serum and leucocytes; the cells of the Malpighian layer of the epidermis, of the dermis, and of the subcutaneous tissue proliferate; the cells of the cuticle are in consequence pushed forward before they have had time to assume their horny character, and the cuticle thus softened readily separates or is rubbed off, leaving the dermis raw and exposed. The infiltrated and softened tissues forming the surface of the sore become disintegrated as in suppuration, and are cast off in a molecular and partly liquid form, while those a little deeper become completely replaced by the leucocytes and proliferating cells which form a layer of vascular granulation-tissue (Fig. 6), essentially similar to that forming an abscess wall. When the cause of the ulceration is removed the circulation around becomes normal, the infiltration of leucocytes and serum and proliferation of the tissue-cells cease, and although the superficial cells of the granulation-tissue at first degenerate and are cast off as pus, under healthy conditions the granulation-tissue soon outbalances in its growth the superficial disintegration and thus fills up the ulcer. New epithelium is formed from the old epithelium at the margin of the ulcer, and gradually spreads over the surface of the granulations till the ulcer is finally skinned over. The granulations develop into fibrous tissue which slowly contracts, helping to reduce the size of the wound.

Causes.—Ulceration, like suppuration, is due to the action of the pyogenic micrococci on tissues weakened by previous inflammation. For a fuller account of the causes of ulceration, therefore, the student is referred to the causes of inflammation and suppuration. Here it may briefly be said that the ulcerations of the integuments so common in surgical practice are generally the result of: 1. Injury, often slight, inflicted on parts the vitality of which is already lowered by poor living, advancing age, and chronic congestions due to varicose veins, long standing, &c. 2. Certain morbid states of the system, such as are produced by syphilis and tubercle. 3. Pressure, especially when conjoined with a defective nerve-supply, as an example of which may be mentioned bed-sores occurring in cases of injury to the spinal cord.

The *treatment* of ulceration varies according to the local condition of the ulcer and the constitutional state of the patient, and will be discussed under Varieties of Ulcers. All that need be said in general is, that the cause should if possible be removed, all sources of irritation avoided, the constitutional state of the patient treated with appropriate remedies, and such dressings applied as are indicated by the local condition of the ulcer.

DISEASES OF CICATRICES.—After an ulcer has healed over and the granulation-tissue has been converted into fibrous tissue, this latter continues to shrink, leading to obliteration of the blood-vessels in the cicatrix and causing contraction and often distortion of the surrounding parts. Cicatrices differ from normal skin in that they are devoid of sweat-ducts, hair-follicles, sebaceous glands, and lymphatics, and being also but poorly supplied with nerves and vessels are very apt to break down on slight provocation, leading to a re-opening of the ulcer. Moreover, owing to their unstable nature, they are liable to undergo certain changes and become the seat of eczema, hypertrophy, keloid, epithelioma, and warty excrescences, and to be attended with itching, pain, and intense neuralgia.

ULCERS.

An ulcer is the term applied to an open sore produced by a loss of substance of the free surface of the skin or mucous membrane in the process of ulceration, or of ulceration and gangrene combined. The term, moreover, is sometimes extended to any open granulating wound the result of an injury or operation.

Varieties of ulcers.—The various names given to ulcers are derived either from their local conditions and surroundings or from their specific cause. The characters of the specific ulcers, however, often become obscured by accidental local conditions, and these latter again are constantly changing from day to day, so that an ulcer which at one time would be called callous may at another be in a sloughing state. The following are examples of the chief types of ulcers, but in practice many minor shades of difference in the local appearances are met with, so that it may be difficult or impossible to assign a given ulcer to a particular type.

A. *Ulcers whose characters depend upon their local condition.*

The simple, healthy, or healing ulcer.—The edges are smooth and shelving, and extend in the form of a bluish-white film over the marginal granulations. The base is level or nearly so, and covered with healthy granulations. The discharge is inodorous pus, or if the ulcer is dressed antiseptically, and all irritation avoided, merely healthy serum. The surrounding skin is healthy. This is the type that all ulcers assume when healing. *Treatment.*—Rest and protection by any light unirritating antiseptic dressing is all that is usually required. When large, cicatrization may be promoted by skin-grafting. Two methods are employed.

(*a*) *Old method of skin-grafting.*—Small pieces of healthy skin, including the rete mucosum or actively-growing epithelial layer but not the whole thickness of the corium, should be snipped from the patient's arm or elsewhere by the skin-grafting scissors and placed at once with gentle pressure on the granulating surface of the ulcer, and retained there by suitable dressings until they have become adherent. After a few days the grafts often disappear, but this may only be owing to the loss of the horny layer of the epidermis which gives them their opacity. The active deeper layer which is

Chronic Non-Specific [illegible] inflamed [illegible]
3. [illegible] Tumours e.g. Carcinoma [illegible]

transparent may still be there, and the grafts, if the process is successful, will become apparent in a few days, as in the course of growth the deeper cells are pushed forward and become horny. From each islet of epithelium thus grafted new epithelium spreads over the surface of the sore. The granulating surface of the ulcer must be healthy or the grafting will not succeed.

(*b*) *New method of skin-grafting* (Thiersch's).—The ulcer should first be brought into a healthy condition, all strong antiseptics washed off with boiled salt solution so that they may not come into contact with the grafts, and the granulations scraped away. Longitudinal shavings of skin should then be taken from the arm or thigh with a sharp razor, carried on the razor to the ulcer, and laid upon its surface. The grafts should overlap the margins or they will in retracting leave a border of granulations. There should be no subcutaneous tissue or fat on the under surface of the graft; indeed it is only necessary to shave off the tops of the papillæ, as the thinner the graft the more easily is it handled. The grafts, if preferred, may be taken from an amputated limb, or from a puppy, rabbit or frog.

The exuberant or fungous ulcer is generally due to obstructed venous return from the granulations, the result of undue contraction of surrounding tissues, as seen, for example, after a burn. The edges are healthy, but the granulations rise up above the surface, and are turgid, dark red, redundant, and readily bleed. The discharge is purulent. *Treatment.*—Solid nitrate of silver or sulphate of copper should be rubbed over the granulations until they are reduced to healthy proportions.

The œdematous or weak ulcer generally occurs in connection with tuberculous bones or joints, but any ulcer may become œdematous if healing is delayed by the too long use of emollient applications. The edges and surroundings are generally healthy; and the granulations are up-raised, flabby, bulbous, semi-translucent, watery, and friable. The discharge is profuse and watery. *Treatment.*—Removal of the cause where possible; uniform pressure; and applications of lotions of nitrate of silver, or like astringents. When tuberculous they should be scraped away.

The inflammatory and inflamed ulcer.—These terms are applied to ulcers in which the inflammatory phenomena are the most marked feature. The inflammation may depend on some constitutional disturbance consequent upon alcoholism, poor living, and the like; or it may be the result of local irritation applied to any ulcer, whatever its previous character. For the purpose of distinction, the term inflammatory' is applied to the former condition, whilst the term inflamed' is generally restricted to ulcers of the latter class. nflammatory ulcers have generally an irregular shape, the edges are ragged and shreddy, or abrupt or sharp-cut; the surrounding skin is red and œdematous, and the base void of granulations, dry, livid red, or covered with a serous or sanious discharge mixed with tissue-débris, and if the inflammation is very acute, with yellow sloughs. When inflammation attacks a previously granulating ulcer, the granulations become florid and swollen, and generally slough, whilst the surrounding parts present the ordinary inflammatory phenomena. The *treatment* should consist of rest, the elevation of the part, the removal of all local irritation, the application of warm antiseptic lotions, as boracic acid, on lint, attention to the constitutional state, and regulation of the secretions.

The sloughing ulcer.—This is merely a severer degree of the former, and it differs from it in that the inflammatory process is more intense and of a spreading character. It is seldom met with except in connection with venereal disease. The micro-organisms at work in this and the next form of ulcer are probably only the ordinary pyogenic micrococci found in all ulcers, but here acting with greater intensity in a vitiated constitution. The ulcer spreads with great rapidity, the edges are undermined, inverted, and dusky red, and the base is covered by an ash-grey or black slough. There is commonly much pain and severe constitutional fever. The *treatment* is similar to that of the inflamed variety. Antiseptics should be freely used if the ulcer is foul, and opium given if there is much pain. When due to syphilis, the proper remedies for that affection should, of course, be given ; but mercury should be used cautiously, or be altogether withheld till the sloughing has ceased.

The phagedænic ulcer, owing to improved sanitation and hygiene, and the more scientific treatment of wounds, is seldom seen at the present day, except in connection with venereal disease in persons whose constitution is thoroughly broken down by intemperance, poor living, and general neglect. The edges of the ulcer are irregular, swollen, and undermined, and the skin around is of a dark, purplish, and dusky-red colour. The surface is devoid of granulations, and covered with a dark blood-stained ichorous discharge often mixed with sloughs. When the sloughing proceeds to any extent, the ulceration is spoken of as *sloughing phagedæna.* The ulcer spreads with fearful rapidity, and often destroys the whole organ, as the penis or vulva, and is attended with severe constitutional disturbance. *Treatment.*—The patient should be placed under an anæsthetic, and the surface of the ulcer dried and then thoroughly destroyed with fuming nitric acid. I prefer this method myself as being most efficacious and radical in its action. Some surgeons are content, however, merely to apply carbolic acid (1 in 20) or perchloride of mercury (1 in 1,000), and then dust with iodoform. The continuous use of the hot bath is often of much service in phagedæna of the penis and vulva. Internally opium should be given in full doses, with tonics, nourishing diet, and when indicated, stimulants. Thorough ventilation and good hygiene generally are imperative.

The chronic, callous, or indolent ulcer.—This condition of an ulcer is the result of continued irritation and neglect, in consequence of which the edges become infiltrated with inflammatory material, which impedes the circulation and prevents healing. It is very common in the lower third of the leg in the poorer classes. The edges are smooth, white, callous, rounded, steep, and quite insensitive when touched. The skin around is generally congested or eczematous. The base is covered with a thin sanious discharge, whilst there are either no granulations, or such as are present are small, flabby, pale, and ill-formed. These ulcers often exist for years, and are usually attended with but little pain, and though they are at times small, at other times they extend nearly round the leg. They are often adherent to the fascia, periosteum, or bone. Old callous ulcers when subjected to continued irritation are apt, as age advances, to become epitheliomatous. *Treatment.*—The callous edges should first be softened by emollient dressings, and uniform pressure subsequently applied by a Martin's bandage, by strapping and a bandage, or by Unna's dressing. The strapping plaister, cut into strips one inch and a half wide, should be evenly applied, and extend two inches below and a like distance above the ulcer. Holes should be cut in the strapping opposite the ulcer to allow of the escape of the discharge. Over the strapping a bandage should be applied from the foot to the knee. The bandage should be changed daily; the strapping once or twice a week. Iodoform or some other antiseptic powder should be sprinkled on the ulcer beneath the strapping. Unna's paste (oxide of zinc 10 parts, gelatine 15 parts, glycerine 30 parts, and water 45 parts) may be applied as follows:—The limb is bandaged with carbolic gauze from toes to knee, covering in the ulcer. A layer of the melted paste is next applied, allowed to dry, and the process repeated. The contraction of the paste exercises uniform pressure on the ulcer and limb above and below. When the ulcer is very large or extends quite round the leg or shows signs of becoming epitheliomatous, amputation is called for.

The varicose and eczematous ulcer.—These terms are applied to any ulcer, whatever its other characters, when associated respectively with a varicose state of the veins or an eczematous condition of the skin. Both conditions frequently occur together, and are described under Varicose Veins.

The irritable or painful ulcer.—Though any ulcer may be irritable or painful, the above terms are generally restricted to a small painful ulcer about the anus (see Diseases of Rectum), and to a small, superficial, generally congested ulcer, commonly situated about the ankle, and occurring chiefly in women beyond middle life. The pain is often intense, and is generally believed to depend upon the involvement of the nerve-endings. *Treatment.* — The improvement of the general health, small doses of opium, and cauterization with nitrate of silver will often suffice to cure the ulcer. In inveterate cases an attempt may be made to divide the nerves subcutaneously after the manner of Hilton.

B. *Ulcers whose characters depend upon their specific origin.*

Tuberculous or Strumous ulcers are generally due to the breaking down of enlarged tuberculous lymphatic glands, the bursting of subcutaneous tuberculous abscesses, or the ulceration of tuberculous or so-called strumous nodules. They are generally multiple and often confluent, forming an irregular indolent sore. The edges are pale, bluish-pink, thin, and undermined. The granulations are pale, œdematous, protruding, and readily bleed when touched. The discharge is thin, yellowish-green and scanty. Enlarged glands and cicatrices of former ulcers are frequently present in their near neighbourhood. The cicatrices are generally raised, pale pink or white, whilst the skin is often puckered-in around them. *Treatment.* — Constitutionally that for tubercle. Locally the sore should be destroyed by paring away the edges and scraping the base with a Volkmann's spoon. The cicatrices may sometimes be dispersed by repeated blisterings or by subcutaneous division.

Syphilitic ulcers.—Primary ulcers or chancres are described under syphilis. Those occurring in the course of constitutional syphilis may be divided into the superficial and deep. (*a.*) The *superficial* occur in the course of pustular and tubercular syphilides, and are often associated with patches of these eruptions on other parts of the body. They are usually circular or crescentic in shape, spreading by their convex margin, and healing by their concave. Their edges are sharp-cut and often surrounded by an areola of dusky redness; their base is but slightly depressed, and of a dark red colour, and is often covered by a yellow slough, or a rupial or ecthymatous scab. Several of these ulcers frequently coalesce, giving rise to a serpiginous or annular form of ulceration, which is very characteristic of syphilis. (*b.*) The *deep* are due to the breaking down of gummata. They are circular or oval in shape; their edges are steep, sharp-cut, slightly scooped out, and of a dull red colour; and their base is depressed and covered with a yellow wet-wash-leather-like slough and the débris of breaking-down tissue. They leave slightly depressed, white cicatrices, often surrounded with pigmentation. *Treatment.*—Constitutionally, iodide of potassium should be given in full doses, combined in obstinate cases with small doses of mercury; whilst locally a boracic poultice may be applied till the slough has separated, and then black-wash, iodoform, or the red oxide of mercury ointment.

Gouty ulcers are such as are met with over gouty parts. They are small and superficial, and the discharge as it dries leaves a chalk-like deposit of urate of soda on the surface of the ulcer. The *treatment* is that for gout.

The scorbutic ulcer.—Should an ulcer exist in a person affected with scurvy, its surface becomes covered by a spongy, dark-coloured, strongly-adherent fœtid crust, the removal of which is attended with free bleeding, and is followed by the rapid reproduction of the same material. The *treatment* is that for scurvy.

Lupous, rodent, carcinomatous, and sarcomatous ulcers will be found described in the sections on Lupus, Tumours, &c.

GANGRENE OR MORTIFICATION.

Although gangrene may occur from causes other than inflammation, it is, as we have seen, one of its results, and is therefore described here. It differs from ulceration in that the affected tissue dies *en masse* instead of in a molecular manner.

General outline of the process.—Let us take as our type gangrene as it occurs in a superficial part as the result of inflammation. The part which was previously hot, red, painful, and swelled becomes cold, gradually falling to the temperature of the surrounding medium. The pain, which just before the gangrene sets in is often of a peculiar burning character, ceases, and sensation is completely lost both to the touch and to other external stimuli. The skin, formerly red, becomes of a peculiar pale earthy colour, mottled in places with patches of green or red. Now the cuticle separates in the form of blebs, or can be removed by gentle rubbing, leaving the dermis below wet and slippery. A peculiar crepitant sensation is felt on pressure, on account of the formation of putrescent gases in the tissues, which, if cut into, are found stained and infiltrated with a reddish fluid. The part next becomes blackish-brown, and emits the peculiar odour of decomposing animal matter. Supposing the process ceases to spread, ulceration is set up at the expense of the living tissue bordering upon the gangrenous part; a bright red line (the *line of demarcation* as it is called) is thus formed between the living and the dead; this deepens, and finally the gangrenous part is thrown off in the form of a *sphacelus* or *slough*, leaving a healthy granulating wound which cicatrizes in the usual way. The *minute changes* which occur during the above process are as follows:—In consequence of the intense action of the micro-organisms and their products on the weakened tissues, the infiltration of leucocytes and proliferation of connective-tissue cells are so excessive that the blood supply of the tissues at the focus of inflammation is cut off by the compression and thrombosis of the smaller arteries and capillaries; and partly owing to the loss of the blood supply, and partly as the result of the direct action of the products of the micro-organisms, the part loses its vitality and dies. The red corpuscles break down, and their hæmoglobin is dissolved in the albuminous fluid infiltrating the tissues, and stains them a deep red; bacteria make their way through the skin and putrefaction sets in. The tissues disintegrate and liquefy, sulphuretted hydrogen and other putrescent gases are generated, and the part rapidly passes through changes similar to those it would undergo if it were no longer in connection with the body. Unless bacteria enter, the tissues undergo mummification or fatty changes (*necrobiosis*), not putrefaction. If the gangrene ceases to spread, the living tissues immediately in contact with the dead part, owing to the irritation of the micro-organisms and their products, become intensely inflamed (hence the red line of demarcation) and, subsequently, in consequence of the action of the products of the micro-organisms and of the leucocytes and proliferated tissue cells, with which they become infiltrated, soften and disintegrate, and pus is formed in the way described under Ulceration. The cohesion of the tissues being thus lost, the dead part is cast off. Hæmorrhage, during the process of separation, is prevented by the thrombi filling the vessels, which subsequently become permanently sealed as explained in the section on Hæmorrhage. Granulations in the meanwhile spring up on the surface of the ulcer left on the removal of the slough, and cicatrization is finally effected. In the meanwhile, if the gangrene is at all extensive, or affects a vital organ, as a knuckle of intestine, it exercises a marked effect on the constitution. The vital powers are depressed, the heart's action is feeble, the pulse small, soft, and quickened, the tongue dry and brown, the lips are covered with sordes, and the appetite is lost; whilst later, as the products of putrefaction are absorbed into the system, symptoms of septic poisoning (*sapræmia*) set in.

The above may be taken as a type of what is called inflammatory gangrene. Gangrene, however, may result from causes other than inflammation, and the dead part, instead of becoming swollen and infiltrated with fluids, may shrivel up and become quite dry and mummified. Hence the division sometimes made into *moist* and *dry* gangrene.

The moist or dry appearance of the part depends to a great extent upon whether the tissues at the time that gangrene supervenes are charged with blood, as in inflammatory gangrene and in gangrene from venous obstruction; or, whether they are more or less deprived of blood, as in gangrene from the blocking of the main artery supplying the part. The two conditions sometimes run into one another, the dead part at first being moist, and subsequently becoming, as the fluids evaporate, more or less dry. The different appearances presented by the gangrenous part will be further described under Varieties of Gangrene, as it varies according to the cause producing it. The *causes* of gangrene, therefore, must first be considered.

Causes.—The immediate cause of gangrene, whether the process is induced by inflammation, as described above, or otherwise, may be said to be any agent which is capable of destroying the vitality of the tissues or cutting off their nutrient supply. The agents capable of inducing one or other or both of these conditions are very numerous. Some of them are in themselves alone sufficient to act in this way. For others, however, to become operative, certain prior changes in the tissues would appear to be necessary. The causes of gangrene, therefore, may be considered under the heads of predisposing and exciting.

The *Predisposing causes* are such as impair the vitality of the tissues, and render them less able to resist injurious influences. They, therefore, include those already given under Inflammation (p. 7), and amongst them may be especially mentioned old age, feeble action of the heart, chronic congestion of a part, deteriorated blood as in diabetes and Bright's disease, and impairment or loss of nerve influence from injury or disease of the nerve-centres or nerve-trunks.

Exciting causes.—These may be considered under the following heads: 1. *Physical or chemical agencies*, which act by directly destroying the vitality of the tissues. Among these may be mentioned mechanical violence, as a severe crushing of the whole or a part of a limb; excessive heat, as in burns and scalds; intense cold, as in frost-bite; chemical action from strong acids, alkalies, putrid secretions, and the like. Although these may act by directly killing the tissues of the part, their action is often aided by inflammation, as seen for instance in a crushed foot, where both the injury and the subsequent inflammation determine the death of the member. 2. *Inflammation* causes gangrene in part by the pressure of the inflammatory exudation and the thrombosis of the vessels cutting off the nutritive supply, but chiefly by the action of the irritant causing the inflammation. The latter is especially the case in the septic and infective inflammations, the noxa here being either the products of putrefaction or micro-organisms, especially the *Streptococcus pyogenes*. Some inflammations always terminate in gangrene, as carbuncle. The manner in which micro-organisms produce gangrene is not determined, but it is believed to be due to the action of their products on the tissues. Special forms of inflammatory gangrene are (*a*) the gangrenous cellulitis, generally caused by the *Streptococcus pyogenes* (*erysipelatosus*); (*b*) the diphtheritic gangrene caused by the *Bacillus diphtheriæ*, and (*c*) the emphysematous gangrene which is associated with gas-forming organisms, notably the *Bacillus aërogenes* of Welch and the *Bacillus coli* *communis.* 3. *Obstruction to the arterial supply*, as from ligature of the main artery, embolism, thrombosis or rupture of the artery supplying the part, and spasm of the arterioles due to long ingestion of ergot. 4. *Obstruction to the capillary circulation* from thrombosis or pressure. As examples of this may be mentioned, bed-sores from pressure of the part between the bed and a point of bone; the death of the skin and bone in cellulitis and periostitis respectively from compression of the capillaries by the inflammatory effusion; local sloughing from the pressure of a splint or a new growth; cancrum oris from thrombosis of the capillaries, &c. 5. *Obstruction to the venous return* as seen in strangulated hernia, paraphimosis, tight bandaging, &c. Obstructed venous return, however, is generally associated with obstruction to the arterial supply as well.

The *Signs of gangrene* vary considerably according to the cause. The general symptoms in the acute inflammatory form have already been given in the outline of the process (p. 37). Those of the special forms will be further mentioned under Varieties of Gangrene and elsewhere, as in the section on Cancrum oris, &c.

The *Treatment*, like the symptoms of gangrene, depends so much upon the cause and nature of the gangrene, that its details can only be given under the special varieties. Here, however, it may be said that the general indications for treatment, whatever the variety, are—(1) To remove where possible the cause, as a tight bandage constricting a limb, putrefactive processes in wounds, tension, pressure, and so on. (2) To prevent gangrene, when threatened, from actually occurring by maintaining the warmth of the part, and endeavouring to relieve the embarrassed circulation by elevating the limb, and by gentle friction when there is venous congestion; and (3) When gangrene has actually occurred, to check it spreading; to promote the separation of the dead from the living part, or remove it by amputation; to control as far as possible the formation of the products of putrefaction by keeping the part dry, and by the free use of antiseptics; to support the patient's strength; to counteract the deleterious effects on the constitution from the absorption of the septic poison; and to soothe pain by opium.

Varieties of gangrene.—We have just seen that gangrene is generally divided into the moist and dry according to the condition of the gangrenous part. Although these may be looked upon as more or less accidental conditions, depending upon the amount of fluid in the tissues at the time that gangrene supervenes, they are convenient for the purpose of classification, and are thus used here. As examples of moist gangrene may be mentioned—(1) Inflammatory gangrene, (2) Traumatic gangrene, (3) Hospital gangrene, (4) Phagedæna, (5) Cancrum oris and Noma, (6) Carbuncle, (7) Bed-sores, (8) Diabetic gangrene. As examples of the dry—(1) Senile gangrene, (2) Gangrene from embolism or ligature of a main artery, (3) Gangrene from frost-bite, and (4) Raynaud's disease. Thus it will be seen that there may be made almost as many varieties of gangrene as there are causes producing it. Here only a brief account of a few of the typical varieties can be given; others, as Hospital gangrene, Phagedæna, Cancrum oris, &c., are described in the sections on Septic Processes in Wounds, Diseases of the Cheeks, Skin, &c.

TRAUMATIC GANGRENE may be divided into the local and the spreading.

Local traumatic gangrene is of common occurrence in surgical hospital practice. It may be the result of a severe injury, such as the crushing of a limb, whereby the tissues are killed outright or their vitality is so lowered that the blood extravasated from the wounded vessels is sufficient in addition to the lowering of their vitality to kill them. Again, it may be due to the rupture of a main artery or vein without any lesion of the skin. The *symptoms* in these cases are as follows:—The limb is cold and swollen, its sensibility is lost or blunted, and the pulse below the seat of injury is indistinguishable. As the patient recovers from the shock of the njury the circulation may return and all may be well; or the vitality of the part may become completely lost, the skin dis-oloured, and the other signs of putrefaction, already described, set n. Here the process is entirely a local one, and is dependent either on constitutional disturbance, inflammation, nor septic gencies. But if the limb be not removed, the septic products will ive rise to local inflammation and to constitutional signs of blood-oisoning. The *treatment* consists in amputation well above the angrenous part as soon as the diagnosis is thoroughly established; ut as long as it is doubtful whether the limb will not recover, he part should be handled with all gentleness, kept warm with otton-wool, and placed at rest on a pillow, while stimulants should e administered, and tight bandaging and splints avoided, as such ight be sufficient to determine the death of the part.

Spreading traumatic gangrene is a much more serious affection. ere the gangrene spreads with fearful rapidity towards the trunk, nd is attended with severe constitutional symptoms. It occurs in wo forms, one of which appears to depend upon the constitutional ndition of the patient; the other upon an infective inflammation. he former occurs in persons whose vitality has been lowered by revious ill-health or internal injury. It usually comes on about e second or third day after an injury that has been generally ough not necessarily severe. The limb becomes swollen, cold, d of an earthy or leaden hue, and the gangrene rapidly extends wards the trunk unattended with any local sign of active inflam-ation; the patient falls into a typhoid condition, and sinks as e gangrene reaches the trunk. The second or infective form is most frequent after severe crushes or bruises of a limb, especially the lower, with injury of the bone, as compound fracture attended with extravasation and retention of blood or serum in the tissues. The gangrene begins at the edge of the wound and spreads up towards the trunk, but is preceded by a blush of inflammatory redness and often by emphysema of the tissues. In this case the gangrene is the result of infective micro-organisms in the wound, associated with gas-forming bacilli; the system becomes poisoned by the absorption of the products of bacterial growth, and the ordinary signs of septic intoxication (*sapræmia*), or general septicæmia with organisms in the circulation, almost always ensue. Infective endocarditis is a common accompaniment.

Treatment.—In the first variety, depending on the constitutional condition of the patient, no treatment hitherto has been of any avail, as the gangrene almost invariably occurs in the flaps if amputation is performed. In the second variety, amputation, as far removed from the injury and gangrene as possible, should be resorted to early, so as to be well above the infiltrated tissues. It is of no use waiting for a line of demarcation, as one does not form. The strength must be supported by stimulants and fluid nourishment, and opium given to relieve pain. As the gangrene often spreads higher along the inner side of the limb, the flaps should in such cases be taken from the outer side. The wound should be packed with iodoform gauze and left open to insure free drainage.

SENILE GANGRENE is generally taken as a typical example of the dry variety, but is often more or less moist when starting in inflammatory action. It is usually the result of calcification or of atheroma of the arteries and consequent clotting of blood on their roughened surface, a cause rendered more effective in old people by the weak propelling action of the heart, and feeble circulation through the lower limbs. It may occasionally be produced by embolism. It often begins apparently spontaneously as a black spot on one of the toes or the side of the foot; or it may start as a slight or diffuse inflammation induced by cutting a corn, a trivial injury of the foot, or ulceration of a bunion, and is often preceded by coldness and numbness, or cramp in the feet. It may gradually involve the whole foot and part of the leg, the parts becoming dry, black, and shrivelled. The process of separation is usually very slow, and at first is attended with very little constitutional disturbance. It frequently terminates fatally. *Treatment.*—It is generally held that the parts should be allowed to separate spontaneously, the surgeon merely stepping in to help nature by severing the bone or any tendons that may remain after the softer tissues have separated. If this treatment is followed the limb in the meantime should be kept at a uniform temperature by wrapping it in cotton-wool; the odour of the gangrenous part kept in check by dressings of iodoform or dried charcoal; the strength supported by fluid nourishment and stimulants; and pain relieved and the circulation controlled by small doses of opium. The result of this treatment, however, is at the best unsatisfactory. It has been proposed by Mr. Hutchinson, therefore, to amputate at a distance from the gangrene, *e.g.* through the thigh in gangrene of the foot, the objection to amputation in the neighbourhood being the liability of the flaps to slough, the risk of secondary hæmorrhage, and the difficulty of securing the arteries. These dangers have probably, however, been much lessened since the introduction of antiseptics, and successful cases of amputation through the thinnest part of the leg—a much less severe procedure in itself than amputation through the thigh—have been reported.

DIABETIC GANGRENE, as the name implies, occurs in persons the subjects of diabetes. The exciting causes of the gangrene are probably the same as in other forms, though arterial disease and peripheral neuritis would appear to be the most common. Diabetic gangrene in some respects resembles senile gangrene in that it usually occurs in moderately old people, starts in the lower extremity, frequently in the toes or the sole of the foot, and is generally the result of a trifling injury, or an inflamed corn, or, at times, of a perforating ulcer. It usually spreads more rapidly, however, shows little tendency to be limited by a line of demarcation, and instead of being dry, generally remains moist. The activity of the gangrene would appear to depend upon the weakened tissues in diabetes being unable to resist the action of micro-organisms and their products, and forming a favourable nidus for their growth. Mr. Godlee would distinguish two chief forms of diabetic gangrene:—In one, depending upon arterial disease, the spread is rapid, the pain great, and there is little tendency to the formation of a line of demarcation. In the other, depending upon peripheral neuritis, the progress is slow, the pain slight, and spontaneous separation may occur. *Treatment.*—Hitherto amputation has been generally deemed inadmissible for fear of sloughing of the flaps, and the treatment has consisted of dry antiseptic dressings, dieting and opium. Recently, however, amputation at a distance, *i.e.* through the thigh in gangrene of the foot, has been successful in the hands of Godlee, Spencer, and others. In the rapidly spreading form amputation at a distance is perhaps the best treatment since the arterial disease generally extends to the knee, but not further. In the more slowly spreading forms the part may be left to separate spontaneously, or be removed just above the gangrenous spot. In all cases the strictest antiseptic precautions must be taken. Do what we will, however, there is always a danger of death from diabetic coma, a condition which is liable to follow the most trivial operation in diabetics.

Raynaud's disease is a peculiar form of spontaneous gangrene usually affecting symmetrically the fingers, toes, and more rarely the ears. It as a rule occurs in children or young persons who have previously suffered for a longer or shorter period from intermittent attacks of numbness and coldness of the extremities, generally brought on by cold weather (*local syncope*), followed later in many cases by blueness and congestion, accompanied by burning pain (*local asphyxia*), which, in its turn, shows a tendency to run into actual death of the part (*gangrene*). The gangrene is usually of the dry kind, but in the toes and shins a bleb often forms, and the parts slough (*moist gangrene*). This condition is supposed to depend upon some disturbance of the vaso-motor nerve-centre inducing spasm of the arterioles, or in some cases upon a peripheral neuritis, but no organic lesion has yet been discovered. Hæmatinuria is frequently observed in association with it. It does not appear at present to have ended fatally. *Treatment.*—The constant descending current, as recommended by Raynaud, or placing the parts in an electric bath, has been attended with good results before gangrene has set in. When this has occurred it must be treated on general principles till the parts have separated. Opium and trinitrine tabloids internally, and massage and belladonna locally, have been recommended when the gangrene attacks the ears.

TUBERCLE AND TUBERCULOSIS.

Tubercle is an inflammatory new growth (*infective granuloma*), depending upon the presence of the tubercle bacillus, and capable of inducing tuberculosis by transference to most animals. Tubercle may be limited to one set of tissues, or to an organ (*local tuberculosis*). Or it may be generally diffused throughout the whole body (*general tuberculosis*).

Structure of tubercle.—Tubercle is met with under two forms, grey miliary nodules and yellow caseous masses. (*a*) The *grey miliary tubercles* have almost the lustre and hardness of cartilage. They are globular in shape and vary in size from a pin's point to a millet or mustard seed. They are sharply defined, and may be scattered throughout an organ or on a serous surface, or be grouped more or less closely. (*b*) The *yellow caseous masses* are soft in consistency and larger than the miliary tubercles, the larger masses being produced by the fusion of several tubercles. Yellow tubercle is believed to be due to the degeneration of miliary tubercle. In some cases of general tuberculosis only the miliary form may be found, in other cases only the yellow variety; but frequently the two forms are mixed, and the various stages from grey to yellow, from the central softening of the miliary tubercle to its complete conversion into a caseous yellow mass, can be traced.

Microscopically a typical grey granulation when of some size is seen to consist of some smaller nodules aggregated together, whilst each of these again is composed of cells of various shapes and sizes, arranged in three zones (see Fig. 7). The inner zone is formed by one or more large branching so-called giant-cells, composed of a granular protoplasm, in which many large distinct oval nuclei containing nucleoli are found. The next zone consists of large single-nucleated cells, arranged between the branches or processes of the giant-cells, which ramify through the zone. These cells are called epithelioid, from their resemblance to epithelial cells. The third or outermost zone consists of lymphoid cells, like ordinary uninuclear leucocytes, or lymphocytes, scattered through a delicate reticulum of branched connective-tissue cells, which is sometimes continuous with the processes of the giant-cells. There is no distinct line of demarcation between the outer zone of lymphoid cells and the surrounding tissues, but often a faint indication of a fibrous ring may be detected. The tubercle-nodule, though often seated upon a small vessel, is itself completely non-vascular. The bacilli may be found in the giant-cells, especially in animals, and in and amongst the epithelioid cells. They are less readily discovered after caseation has commenced. They are rod-like bodies, usually straight, sometimes curved, rounded at the ends, and about one-fifth their length in breadth (see Fig. 8). Although he above may be regarded as the typical microscopical appearance f a miliary tubercle, often neither giant-cells nor epithelioid cells re present, while both these may be found in chronic inflammations which are not tuberculous.

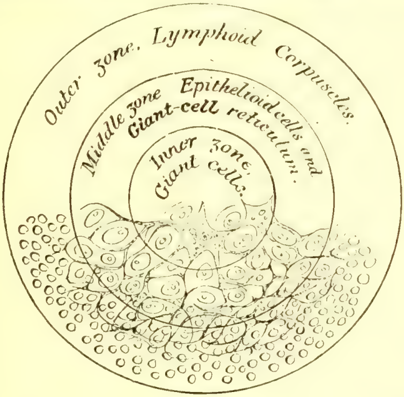
Outer zone, Lymphoid Corpuscles.
Middle zone Epithelioid cells and Giant-cell reticulum.
Inner zone Giant cells.

FIG. 7.—Diagram of the minute structure of tubercle.

Development of tubercle.—The tubercle bacilli having gained entrance to the body may remain at the point of entrance or be carried by the blood or lymph stream to other and perhaps distant parts.

A tuberculous nodule commences by the proliferation of the tissue cells at the spot where the bacilli may have lodged. Nuclear and cell division give rise to an aggregation of young epithelioid cells. At this stage small round cells make their appearance at the circumference of the zone of epithelioid cells. The giant-cells are probably formed by the growth of a single cell or fusion of several epithelioid cells accompanied by division of the nucleus or nuclei. They are therefore of later development and to some extent are a sign of chronicity. Giant-cells are not an essential part of a tuberculous nodule, and may be present in any *chronic* inflammation.

Secondary changes.—(1.) Tubercle, probably on account of the absence of blood-vessels and the pressure of the invading leucocytes, and possibly also on account of the noxious influence of the bacilli, is very liable to undergo caseous degeneration. This change begins at the centre of the tubercle in the giant-cells, and spreads outwards. (2.) In chronic tuberculosis, instead of caseation occurring, a capsule of fibrous tissue may be formed around the nodule, and the cicatrization extending inwards until the giant-cell is involved, the whole tubercle may be converted into a mass of fibrous tissue. The tubercle bacillus is not found under such conditions. (3.) After caseation has occurred the tubercle may become encysted, may undergo calcification, in both of which states it may remain harmless; or (4) it may become infected with pyogenic micrococci, which, acting as irritants, set up inflammation and suppuration in the tissues around, leading to the formation of an abscess, and subsequently on its bursting to an ulcer.

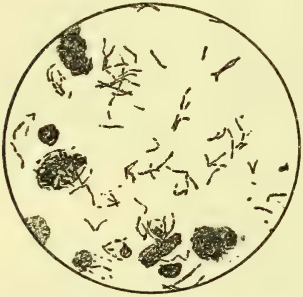

Fig. 8.—The tubercle bacillus. (After Mcintyre.)

Cause.—The immediate exciting cause of tubercle is the presence of the tubercle bacillus. The bacillus is believed in man to gain admission (1) by the *digestive tract*, as in the saliva of a phthisical mother or nurse, in milk taken from cows with tuberculous udders, or in imperfectly cooked tuberculous meat; (2) by the *respiratory tract*, as by the inhalation of the dust of dried phthisical sputa, &c. (*aërogenous tuberculosis*); and (3) by the *skin*. It is still doubtful if man is often inoculated through the skin; at any rate, there then seems little or no tendency for tubercle to spread beyond the point of inoculation.

Predisposing causes.—For the bacillus to take effect a lowering of the vitality or resisting power of the tissues appears to be necessary. Such a condition of the tissues may be present (1) in children born of phthisical parents (hence *heredity* in this sense may be said to be one of the chief predisposing causes, but it must be remembered that tubercle is not transmitted from the parent to the offspring as is syphilis); (2) in the so-called *strumous diathesis;* and (3) in certain states of the system induced by bad hygiene and food, and imperfect assimilation of food and consequent impairment of nutrition. Tubercle is most common in the young, but adults and even old people are liable to it when exposed to like unfavourable conditions, a slight inflammation or injury then generally forming the starting point.

Dissemination of tubercle.—The bacillus having gained admission in one or other of the above-mentioned ways is believed to set up the tuberculous process as previously described. The tuberculous process may then (1) remain confined to the seat of inoculation, as in some forms of tubercle of the skin (*lupus and post-mortem warts*). Or (2) with or without any local manifestation it may spread by the lymphatics to the nearest lymphatic glands and there become arrested. As an example of this may be mentioned the tuberculous enlargement of the glands of the neck, in which the bacillus is believed to gain admission through a crack or small ulcer of the mucous membrane of the mouth or through an inflamed tonsil. Again, (3) the bacillus may pass the glands and enter the lymphatic or hæmic circulation, and then either (*a*) become lodged in some organ or distant part of the body, as the testicle, a bone or a joint, or (*b*) become disseminated, setting up general acute tuberculosis (*lymphogenous and hæmatogenous tuberculosis*). The brunt of the affection falls in the latter case either on the lungs (*acute tuberculous phthisis*) or on the membranes of the brain (*acute tuberculous meningitis*). When affecting an organ or tissue, as a testicle or a joint, it may remain localized for a longer or shorter time, and even become cured; or it may set up inflammation, and involve and destroy the whole organ; or finally become generally disseminated through the system, leading to general tuberculosis.

Localization of tubercle.—Tubercle has a special affinity for certain organs and tissues to the exclusion of others. Serous membranes, such as the pleura, peritoneum, pia mater, and arachnoid, are especially liable to be affected; whilst, on the other hand, the pericardium and the tunica vaginalis show an immunity. Of all organs the lung is most prone to suffer; next, though much ess frequently, the testicle, kidney, brain, liver, spleen, suprarenals, and ovaries. The larynx and intestines may become involved by the bacillus coming into contact with them either in the breath or swallowed sputa; yet the trachea, the stomach, and the upper part of the intestine generally escape. The bones and joints are frequent seats of the disease, which has a special predilection for the cancellous ends of the long bones and the short bones. The upper end of the femur and hip-joint, the ends of the femur and tibia forming the knee-joint, and the short bones and joints of the foot and hand are most often affected, the elbow-joint less often, and the upper end of the humerus and the clavicular joints but rarely. The scapula and ilium with the acetabulum may suffer, but the shafts of the long bones, the clavicle, and the ischium and pubes, apart from the acetabulum, escape. The bodies of the vertebræ are frequently attacked, while the laminæ, with the spinous and transverse processes, remain free. The bones of the skull are rarely involved, those of the jaws and face never. Tuberculosis may occur in the skin and affect the glands, but lupus, which is a form of tuberculous disease, does not spread to the glands. The reason for tubercle affecting any special organ or tissue is not known, but it is thought to depend on some previous lowering of vitality of the part, as a sprain of a joint, a blow on the testicle, &c.

A general though brief account of tubercle has been here given to prevent repetition when treating of tuberculous diseases of certain organs. As a surgical affection, it is chiefly met with in the bones, joints, testicle, lymphatic glands, skin, larynx, and more rarely in the bladder and rectum. All that need here be said is, that such lesions are of a very chronic and indolent nature; that they are set up by very slight and apparently inadequate causes; that they exhibit a marked tendency to suppuration and progressive destruction or undermining of the tissues, and but little tendency to repair; that they are often productive of much scarring and deformity, as when they occur as abscesses in the neck; that they are generally very obstinate and intractable as regards treatment; and that they may terminate in general dissemination of the tubercle through the body, and death.

The *treatment* should be both constitutional and local. Thus the patient should be placed under as perfect hygienic conditions as possible, with residence at the seaside, preferably Cromer or Margate, or where practicable he may go a sea voyage. The diet should be nourishing but unstimulating, with plenty of milk and cream, whilst cod-liver oil or maltine and the syrup of the iodide or phosphate of iron are especially indicated. Koch's tuberculin has now had extensive trial in surgical tuberculous affections. My own experience of it has been unfavourable, and such would appear to be that of the majority of surgeons. A grave objection is the danger of setting up general tuberculosis. The local treatment required for the various lesions that may be present is given when describing these lesions as they occur in special tissues and organs.

STRUMA OR SCROFULA.

The terms struma and scrofula are here used synonymously. To prevent confusion the former, as perhaps the one in more general use, will be subsequently employed. By struma or strumous is generally understood a constitutional condition or diathesis, in which, on very slight provocation, chronic inflammations of certain tissues and organs, preferably skin, mucous membrane, lymphatic glands, bones, joints, and testicle are set up, run an indolent course, and have a marked tendency to caseation and suppuration. By most pathologists, however, these chronic inflammatory processes, which have been supposed to be characteristic of struma, are considered to be in themselves of a tuberculous nature, and dependent on the presence of the tubercle bacillus; whilst what is here called the strumous diathesis is regarded by them merely as a phase of ill-health or malnutrition, favourably disposing the subject to tuberculous infection. Such observers, therefore, regard the terms strumous and tuberculous as synonymous. The histological characters and the general behaviour of the so-called strumous inflammations are no doubt in many respects similar, if not identical, to those which are on all hands regarded as tuberculous, and in many of them the tubercle bacillus has been found. In others, however, even after a careful search, it has not been discovered microscopically; and, therefore, until the presence of the tubercle bacillus has been demonstrated by animal experiments, it is unsafe to assert that all the so-called strumous inflammations are tuberculous. The constitutional condition or diathesis, moreover, regarded by surgeons as strumous, is certainly something more, though difficult to define, than a mere state of debility or feeble health. It would appear, therefore, that the so-called strumous inflammations, though generally tuberculous, are sometimes of a simple chronic character, and only distinguishable from ordinary chronic inflammations by the indolence of their course and the tendency of their products to undergo caseation or become secondarily infected by the tubercle bacillus; and further that the strumous condition or diathesis is a constitutional state in which certain tissues and organs possess a feeble resisting power, and are hence exceedingly liable to be infected by the tubercle bacillus or on very slight injury to become inflamed, whilst the most trifling irritation, as friction, tension, or pressure, is then sufficient to keep such inflammation up.

The *causes* of the condition known as the strumous diathesis are hardly known, but it is thought to be hereditary, and has been attributed to bad hygienic conditions of all kinds, as impure air, dark and damp dwellings, improper or insufficient food, &c. It is said to be especially common in children born of dyspeptic or phthisical, or very young or very old parents. Syphilis in the parent is also believed by some to be a cause.

Symptoms.—The general symptoms which are usually regarded as strumous, irrespective of any of the local lesions, as enlargement of the tonsils or of the lymphatic glands, eczematous eruptions of the skin, disease in the bones or joints, and catarrh of the mucous membranes, are thus given by the late Sir William Savory, who speaks of two chief forms of the diathesis:—"In the first, distinguished as the *sanguineous* or *serous*, there is a general want of muscular development; for although the figure may be sometimes plump and full, the limbs are soft and flabby; the skin is fair and thin, showing the blue veins beneath it; the features are very delicate; often a brilliantly transparent rosy colour of the cheeks contrasts strongly and strikingly with the surrounding pallor; the eyes, grey or blue, are large and humid, with sluggish pupils sheltered by long silken lashes; hair fine, blonde, auburn, or red; teeth white and often brittle; there is frequently a fulness of the upper lip and alæ nasi; the ends of the fingers are commonly broad, with convex nails bent over their extremities. Such persons usually possess much energy and sensibility, with elasticity and buoyancy of spirits; they often possess, too, considerable beauty. In this variety, with the same delicacy, the skin and eyes are sometimes dark. In the second, distinguished as the *phlegmatic* or *melancholic*, the skin, pale or dark, is thick, muddy, and often harsh, the general aspect dull and heavy; hair dark and coarse; the mind is often, but not always, slow and sluggish. Children especially, in whom the diathesis is strongly marked, are often distinguished by the narrow and prominent chest, the tumid and prominent abdomen, and the paste-like complexion; the limbs are wasted; the circulation languid; chilblains are common on the extremities; the mucous membranes particularly, and above all of them the digestive, are liable to morbid action; the breath is often sour and fœtid; the tongue is furred, and the papillæ towards the apex red and prominent; the bowels act irregularly, and the evacuations are unusually offensive; the digestion weak; the appetite variable and capricious."

An account of the lesions of the skin, mucous membranes, tonsils, lymphatic glands, bones, joints, testis, &c., which were regarded by the older pathologists as local symptoms of struma, but are now believed to be due to tuberculous infection, is given in the section on Diseases of Regions.

SYPHILIS.

Syphilis may be divided into (1) the acquired, and (2) the inherited or congenital.

ACQUIRED SYPHILIS is a constitutional disease due to direct inoculation with a specific virus. It is characterized by the appearance, after a certain period of incubation during which the poison is circulating in the system, of a local lesion at the seat of inoculation, followed by induration of the nearest lymphatic glands, and after a variable time by certain affections of the skin and mucous membranes and more rarely of the deeper tissues, and still later by fibroid changes in the tissues and viscera, or the formation of gummata which are exceedingly liable to break down and suppurate.

General outline of the disease.—Beyond perhaps a slight abrasion, which heals in a few days, and is possibly thought no more of, nothing is probably noticed till about three weeks to a month. Attention is then called to the part by a slight irritation, and a red papule may be noticed which slowly enlarges, becomes indurated at the base, and perhaps ulcerates. This papule or ulcer is called the primary *chancre*, and the period which intervenes between the date of inoculation and its appearance, the *period of incubation*. The induration of the sore increases, and the neighbouring glands become hard and shotty. In from six weeks to three months from the date of inoculation, affections of the skin and mucous membrane begin to show themselves, and are known as *secondary* manifestations. The period between their appearance and the induration of the chancre is sometimes called the *secondary incubative period*, during which time malaise, pain in the limbs, lassitude, &c., are noticed. The secondary affections are symmetrical, and though generally confined to certain superficial changes in the skin and mucous membrane, at times attack the deeper structures, as the bones, iris, &c. The secondary stage may last from two months to two years, and no further changes may manifest themselves, the disease appearing to be worn out; or after a few months or years of apparent cure, further changes, known as *tertiary* symptoms, may make their appearance. The tertiary affections are asymmetrical, and not only attack the superficial parts, but are especially common in the deeper structures, as the bones, periosteum, and viscera. They consist in the formation of gummatous material in the skin and mucous membrane, which is very prone to break down and ulcerate; and of gummatous swellings in the bones, periosteum, and viscera, leading to suppuration, fibroid changes, necrosis, serious contractions, paralysis, &c. The tertiary affections may last for years or even for life, and not infrequently terminate fatally when involving vital structures. It should be thoroughly understood, however, that there is no hard and fast line between the secondary and tertiary stages of syphilis. The one may merge into the other, or the secondary symptoms may last into the period usually assigned to the tertiary, whilst the latter may show themselves a few months after the first appearance of the sore. Syphilis, like the exanthemata, as a rule confers immunity upon the patient from a second attack, although in rare instances a second attack has been known to occur. As long as the patient shows secondary manifestations of syphilis, it will probably be transmitted to any offspring. Hence, as a rule, a patient should not be allowed to marry for fully two years after the disappearance of the secondary symptoms.

PRIMARY SYPHILIS.—The primary or infecting chancre, or hard sore as it is sometimes called, though most often met with on the genitals, may occur on any part of the body exposed to infection, and hence is not infrequent on the fingers of accoucheurs, the lips, nipple, &c. On the genitals its most frequent situation is on the prepuce just behind the corona glandis in the male, and on the inner surface of the labia in the female; but it is often met with on the glans, the skin of the penis, and just within the urethra; more rarely on the vaginal walls and os uteri. It is commonly produced by direct contact with another chancre, or a mucous tubercle or other secondary lesion; but it may also be contracted indirectly in many ways, as by drinking out of an infected vessel, or by inoculation with infected lymph in vaccination. The exact nature of the virus is not known, but is believed by many to be a specific micro-organism. It is probable that it is generally inoculated through a crack or abrasion, except in situations where the skin or mucous membrane is very thin and delicate. The period of incubation varies from ten days to six or seven weeks or even longer. When, however, the syphilitic virus is inoculated in the pure state it usually gives rise to no sign till three to five weeks, when a small papule will be noticed, which enlarges and becomes indurated at the base, and may either remain as an indurated nodule throughout, or if irritated change into a small ulcer. Not infrequently, however, the virus may be conveyed in the pus of a non-infecting or soft chancre, under which circumstances a soft chancre will form in two or three days whilst the syphilitic poison is still circulating in the system, and after the incubative period is passed will manifest itself locally by induration about the base of the soft sore, or if this is healed, by an indurated nodule at its former site. The characters of an infecting chancre vary. In the typical form (*Hunterian chancre*) it is raised though slightly depressed at its centre, whilst its surface is either glazed or covered with epithelial débris or scanty secretion; there is scarcely any inflammation, but marked and sharply circumscribed induration about its base. The induration, however, may be absent in chancres on the glans penis and on the female genitals, and is seldom well marked in chancres on parts of the body other than the genitals. It must be borne in mind, moreover, that a non-infecting sore when inflamed may be attended with some inflammatory induration, and hence may be mistaken for an infecting sore. This inflammatory induration, however, is diffused, and fades away into the surrounding parts; whereas the induration of an infecting sore feels as if a piece of cartilage or parchment had been inserted under the skin. Infecting chancres, though usually single, may be multiple if several spots are inoculated at the same time, all then appearing at the same stage of development; but when a primary chancre has once declared itself, showing that the system is impregnated with the poison, other chancres can no longer be produced by inoculation in the same patient. The duration of a primary chancre varies. It usually disappears quickly under the influence of mercury, but if untreated may last for many months. The lymphatic glands generally become enlarged about the same time as the induration of the primary sore, a condition known as *indurated bubo*. Thus, if the chancre is on the genitals or about the anus, the inguinal glands are those affected; if on the finger, the epitrochlear or axillary; if on the lip, the submaxillary. They have a hard, shotty feel, remain distinct from each other, are painless, not adherent to the skin, and do not, as a rule, suppurate. The induration is commonly greater in the inguinal glands than in those of other situations; but, at the same time, the enlargement is not so marked. The induration may subsequently affect all the glands of the body, especially the posterior chain in the neck. If the chancre is irritated or inoculated with pus from a soft chancre, or a soft chancre has formed simultaneously, then a *suppurating bubo* may occur.

SECONDARY SYPHILIS.—The secondary symptoms consist of certain affections of the skin and mucous membranes, general enlargement of the lymphatic glands, and more rarely of inflammation of such deeper structures as the iris and periosteum. They generally set in from six weeks to three months after the appearance of the primary sore. They may assume a very severe or a very mild form, or they may not occur at all, or may be so slight as to be overlooked.

The *skin eruptions* may take various forms. The earliest to appear is usually a *roseolous* rash over the chest and abdomen. It is generally accompanied by a congested condition of the mucous membrane of the fauces, giving rise to a slight sore-throat. This rash is produced merely by local congestion, and hence fades on pressure and usually disappears in a short time. But should the congestion continue, some infiltration of the skin may occur, and the epithelium take on increased growth, and be thrown off in the form of scales, the eruption being then known as a *scaly* syphilide or *psoriasis*. Should further infiltration occur, a *papular* syphilide, or *lichen*, may be produced; or if the process is more acute, serum may be exuded, and raise the cuticle in the form of small vesicles, or even of large blebs, conditions which are spoken of as a *vesicular* syphilide or *eczema*, and as a *bullous* syphilide or *pemphigus* respectively. Both, however, are rare, and the latter seldom occurs, except in congenital syphilis. Still later, especially where the patient is debilitated, the vesicles may be converted into pustules (*pustular syphilide*), while the pustules again may dry into scabs, which fall off, leaving no scar beneath (*syphilitic ecthyma*); or if the patient is cachectic, or his constitution broken down, ulceration may ensue beneath the scabs (*rupia*). The appearance presented by rupia is peculiar. As the ulceration proceeds in depth and extent, larger and larger scabs are successively formed beneath those above which are thus pushed forward, giving the mass the appearance of a limpet-shell. Each rupial spot is surrounded by a dusky-red areola, and on the separation of the scab, a foul circular ulcer is left, which, on healing, leaves a permanent scar. Rupia by some is regarded as an early tertiary, by others as a late secondary, affection. With the exception of rupia the eruptions in syphilis resemble those due to non-syphilitic causes. They are, however, all modified by their coppery or raw ham colour, by more or less surrounding pigmentation, by their symmetrical arrangement, by the circular or crescentic shape of the patches, by the absence of itching, by the absence of the large silvery scales seen in ordinary psoriasis, by their predilection for certain situations, *i.e.*, the chest and abdomen, the space between the shoulders, the back of the neck, the forehead, especially about the roots of the hair, the palms and soles, and the flexor aspect of the limbs; and lastly, by their polymorphism, *i.e.*, their mixed character, the eruption being here papular, here scaly, here pustular, &c. In situations where the parts are moist, as about the mouth, anus, and scrotal folds, the papillæ become succulent and the epithelium sodden, forming *condylomata*. Where such occur between the toes, ulceration may ensue (*rhagades*); but this condition is not common, except as the result of uncleanliness. *Condylomata* appear as low, soft, flattened, sessile elevations of a whitish colour, with a smooth surface, covered by a moist secretion, and often of considerable size. They are intensely contagious, and when occurring where two skin surfaces are in contact, as about the anus and labia, are usually symmetrically placed on either side. The affections of the *mucous membrane* are similar to those of the skin, and are also usually symmetrical. At first, they consist of mere congestions, later of infiltrations with overgrowth and soddening of the epithelium (*mucous tubercles*), and subsequently of superficial ulcerations from the breaking down of the infiltrating inflammatory exudation. Mucous tubercles are especially common about the palate and fauces, side of the tongue, lips, and cheeks, and appear as slightly elevated whitish-looking patches, giving the part somewhat the appearance of having been rubbed over with nitrate of silver. The ulcers, which occur in similar situations, particularly about the tonsils and corners of the mouth, are usually of a crescentic shape, with sharp-cut edges, and are quite superficial. Similar mucous patches and ulcers may occur in the larynx or about the anus or in the rectum.

During the later secondary stages, besides the superficial eruptions and ulcerations which may still be present, the deeper structures may become involved. Amongst these may be mentioned the iris, periosteum, bones, joints, ear, and testicle. The lymphatic glands, not only those nearest to the primary sore, but over all the body, become affected, the posterior cervical more particularly so. This condition is of service in diagnosis; but as it gives rise to no symptom, it is generally overlooked by the patient. *Syphilitic iritis* is especially characterized by the presence of nodules of lymph on the iris, the effusion into the anterior chamber, the comparatively small amount of pain, and its amenability to mercurial treatment. But the irregular pupil, discoloured iris, circumcorneal zone of congestion, photophobia, and patches of pigment on the lens, are also present as in other forms of iritis. The *periostitis* seldom gives rise to the distinct nodes so common in the tertiary stage; otherwise the symptoms are similar. The *joint-affections* are like those in rheumatism, and exhibit nothing very characteristic. *Epididymitis* and *orchitis* are occasionally observed, and are then generally symmetrical, thus differing from the gummatous affections of the testicle in the tertiary stage.

The general health usually suffers, the hair becomes thin (*syphilitic alopecia*), and the patient anæmic. At times severe cachexia ensues, attended by much wasting and prostration.

TERTIARY SYPHILIS.—The symptoms of the tertiary stage commonly occur after a period of apparent cure, sometimes within a few months after the cessation of the secondary symptoms, at other times not till after many years. Occasionally, however, they may be manifested within a few months of the primary sore, *i.e.*, during the period usually assigned to the secondary stage. Moreover, between the termination of the secondary and the onset of the tertiary, certain skin eruptions, enlargements of the testicle, choroiditis, inflammations and ulcerations of the tongue, and psoriasis of the palms may occur, and have been spoken of as "reminders." They are by some regarded as constituting an intermediary stage. The tertiary affections proper are of a more serious nature than the secondary, and show no tendency to spontaneous cure. They depend upon chronic inflammations in various tissues and organs leading to the formation of granulation-tissue (*gummata*). The gummata may undergo caseation and break down, producing when situated in the subcutaneous and submucous tissue characteristic ulcers; or they may continue for indefinite periods, or be slowly absorbed under appropriate treatment, leaving fibroid thickenings and scarrings in the capsules and substance of the affected organs. These gummata vary in size from a pea to a walnut, and are intimately blended with the surrounding tissues. They consist, roughly, of three zones; in the central, the cells are breaking down and undergoing fatty change; in the next zone the cells are contained in a fibrillated matrix; in the outer zone numerous vessels ramify among the cells. The breaking down of the central portion is attributed to changes in the vessels causing a diminution of their calibre or complete thrombosis, whereby the blood-supply of the central zone is cut off and degeneration consequently ensues. Amongst the most common of the tertiary lesions may be mentioned—1, chronic gummatous inflammation of the periosteum and bones, leading to the formation of nodes, caries, or necrosis, and giving rise, as when attacking the bones of the nose, to horrible deformity; 2, gummatous infiltration of the skin and mucous membrane (*tubercular syphilide*) terminating in serpiginous ulceration; 3, gummatous swellings in the subcutaneous and submucous tissue, which may break down, forming deep ulcers the cicatrization of which causes severe contractions, as for instance those seen in stricture of the pharynx, glottis, and rectum; 4, gummata in the muscles; 5, gummata in the tongue, producing scarring and ulcers apt to terminate in epithelioma; 6, affections of the nervous system leading to paralysis; 7, affections of the arteries leading to embolism or aneurysm; and 8, gummata, followed by contraction and fibroid changes in the liver, lungs and other viscera. The various tertiary lesions will be further described under Diseases of the special Tissues and Organs; for those affecting the lungs, liver, kidneys, and nervous system, a work on Medicine must be consulted. Here it must suffice to say that the tertiary lesions are usually asymmetrical; that they are not, as a rule, contagious; that they are chronic in their course; and that they often prove fatal by affecting important organs, as the lungs or brain, or by causing constriction of a passage, as the larynx or rectum.

The *treatment* of syphilis necessarily varies according to the constitutional condition of the patient and the stage of the disease. The *primary sore* requires no other *local* treatment than the application of iodoform or black-wash and protection from irritation. Some, however, still advocate its destruction by caustics or complete excision, and further recommend removal at the same time of the nearest indurated glands. The majority of surgeons have regarded such treatment as useless, believing that the induration of the primary sore is merely an indication that the disease is already established in the constitution. Moreover, excision has repeatedly failed to prevent the occurrence of secondary symptoms. At the International Medical Congress at Berlin, however, the consensus of opinion was in favour of the possibility of aborting the disease by an early excision. *Constitutionally*, mercury in some form is by the majority of surgeons thought to be necessary in all cases. It must, however, be given with caution to strumous and tuberculous subjects, and to persons whose constitution is impaired by dissipation, alcohol, or bad living. It should be withheld in chronic Bright's disease; nor should it be forgotten that some patients exhibit a peculiar idiosyncrasy, in that they are violently salivated by a grain or two of the drug. Mercury may be given—1, by the mouth; 2, by inunction; 3, by fumigation; 4, by subcutaneous injection; and 5, by intra-venous injection. It is, as a rule, perhaps, best given by the mouth, either in the form of a pill or mixture. As a pill, the green iodide in doses of gr. $\frac{1}{2}$ to grs. 2, combined with gr. $\frac{1}{8}$ to gr. $\frac{1}{6}$ of opium to prevent purging, may be given two or three times a day, or the mercury and chalk powder in doses of from grs. 2 to grs. 3, or calomel or blue-pill may be substituted for it. As a mixture, the perchloride in doses of gr. $\frac{1}{32}$ to gr. $\frac{1}{16}$, combined with ammonia, is very useful. The green iodide possesses an advantage, in that the iodine prevents an accumulation of mercury in the system. Tannate of mercury is highly recommended by some surgeons, since, being unaffected by dilute acids, it passes through the stomach without change, but on reaching the duodenum is reduced by the alkaline secretions to its metallic state, the globules being so minute that they are believed to be capable of absorption by the villi. Hence it is less liable than other preparations to set up gastro-enteritis and diarrhœa, and having no cumulative properties there is less fear of salivation. It is rapidly absorbed and as quickly eliminated by the urine. The drug, moreover, is stable. It should be given in the form of a pill in doses of gr. $1\frac{1}{2}$. Where mercury given by the mouth causes much irritation of the bowels, it may be used in the form of an inunction, half a drachm to one drachm of mercurial ointment being rubbed into the inner part of the thigh or the axilla night and morning, the parts being thoroughly washed every day to prevent the ointment accumulating in the sweat-ducts, &c. This is a rapid way of bringing the patient under the influence of the drug, as is also fumigation with calomel or other preparation of mercury, though this latter method may be followed by violent salivation. Subcutaneous injection appears to possess no special advantages over the other methods except perhaps in obstinate tertiary nerve lesions, and is apt to cause sores or abscesses at the point of puncture. The preparations commonly injected are the perchloride, gr. $\frac{1}{8}$ to $\frac{1}{4}$, the salicylate, gr. $1\frac{1}{2}$. When injected with liquid paraffin as the vehicle signs of pulmonary embolism have been observed. The effects of the mercury should be judged by its action on the primary sore and secondary affections. Under its influence the induration of the sore rapidly disappears, and the rash fades. It should never be pushed beyond causing a slight soreness of the gums, the formation of a red line on their free margin, and tenderness on biting. Should salivation occur, the mercury should be immediately stopped, a gentle purgative given, the mouth rinsed with a gargle of chlorate of potash, and iron taken internally. The mercury should also be intermitted for a few weeks or so at a time if symptoms of depression come on. During the mercurial course the patient should avoid chills and abstain from alcohol, fresh fruit, and food liable to disturb the digestion and set up diarrhœa. The mercurial course may with advantage be continued for a year or more, and on its termination iron, tonics, and cod-liver oil should be given, whilst change of air and the baths of Aix-la-Chapelle or Harrogate will be found beneficial. If mercury cannot be taken or is contra-indicated, iodide of potassium with a tonic treatment may be tried. Of the effects of injection with serum taken from immune animals rendered further immune by the introduction of blood from patients with secondary syphilis, it is too early to speak with any certainty. So far the treatment does not appear to equal that with mercury. During the *secondary stages* mercury should still be continued internally. Locally, condylomata are best treated by dusting them with equal parts of calomel and oxide of zinc, under which they dry up very rapidly. Mucous tubercles about the fauces may be gargled with black-wash; superficial cracks and ulcers on the lips, tongue, &c., may be touched with a strong solution of nitrate of silver, or a lotion of bicyanide of mercury or chromic acid. Iritis should be energetically treated by mercury, or if this is already being given, the dose should be increased, whilst locally atropine should be dropped in the eye, and if there is much pain and the congestion is acute, leeches or blisters should be applied to the temple. In the *tertiary stages* iodide of potassium has the most marked effect. It may often be advantageously combined with ammonia, quinine, iron, or cod-liver oil, or even with small doses of mercury if the affection proves intractable. If badly tolerated kola chocolate may be given with it, or iodide of sodium or ammonium substituted for it. In tertiary nerve lesions intramuscular injections of perchloride of mercury (gr. $\frac{1}{8}$) or of salicylate of mercury (gr. $1\frac{1}{2}$) are strongly recommended. The injections are usually made once a week or oftener in the gluteal region, the syringe being passed deeply into the underlying muscle. In intractable cerebral syphilis, where there is great pain or a vital part is involved, intra-venous and para-venous injections of mercury have been attended with brilliant results. A ligature is applied above the vein selected, usually one at the bend of the elbow, the needle thrust into the vein, the ligature loosened, the syringe attached, and one gramme to four grammes of a 1 per cent. solution of perchloride or cyanide of mercury injected. The strictest antiseptic precautions should be observed. The chief advantage claimed for this method is that it succeeds after all other methods have failed. In the para-venous method the mercuric solution is injected in the neighbourhood of the vein, into which it is said to pass by endosmosis.

The treatment of tertiary syphilis will be referred to more in detail under the Diseases of Tissues and Organs.

Should phagedæna occur, it must be energetically treated by the continuous hot bath, or by the destruction of the ulcer with fuming nitric acid or acid nitrate of mercury.

Congenital or inherited syphilis is syphilis transmitted to the offspring by one or both of the parents, and must be distinguished from syphilis contracted by the infant coming in contact with a chancre on the genitals during birth, which would be a case of acquired syphilis. *Cause.*—The poison is transmitted through the spermatic fluid of the father or the ovum of the mother, and *not* by direct inoculation and the formation of a primary chancre as in the acquired form. *Symptoms.*—The child is usually born healthy, and though the virus is present in the system, the disease does not manifest itself as a rule till the fourth to the sixth week. In rare instances, however, infants are born with well-marked signs of syphilis; and at times the affection does not show itself till much later in life. But in the latter case the symptoms are those of the tertiary stage, not those of the secondary stage delayed. The symptoms in a typical case usually set in with a chronic catarrh of the nasal mucous membrane, popularly known as the *snuffles*, followed by a rash on certain parts of the body and mucous tubercles and superficial ulcerations about the mouth and anus. The catarrh may simulate merely a cold in the head, or be attended with a muco-purulent discharge, and cause obstruction to respiration and difficulty in sucking. The eruption, like that of the secondary stages of acquired syphilis, is symmetrical, and of the same peculiar coppery or raw ham colour. It is most common about the nates and genitals, where it is usually erythematous in character, and on the palms of the hands and soles of the feet, where it is commonly squamous. But it may be papular and at times bullous or pustular. A well-marked mucous tubercle or condyloma about the anus is pathognomonic of the disease. These symptoms are frequently, though not invariably, accompanied by anæmia and wasting, the child looks shrivelled and old, the skin earthy and dry, whilst the hair may fall off, and the nails, iris, periosteum, and bones may be affected as in the acquired form. At this period death is far from uncommon. Usually, however, and especially under a mercurial course, the symptoms gradually subside, and by the end of the first year disappear altogether and no further manifestation of the disease may occur throughout life. But frequently after several years of immunity certain tertiary affections show themselves, the chief of these being interstitial keratitis, periostitis, and osteitis, followed by necrosis, disease of the ear often ending in total deafness, ulceration about the palate, chronic synovitis of one or more of the joints, and the formation of gummata in the viscera, testicle, &c. Along with these, certain important diagnostic symptoms, the result of the former secondary lesions, may be present, viz.: 1, a depressed and widened condition of the bridge of the nose, due to the influence of the nasal catarrh upon development of the nasal bones and septum; 2, radiating scars about the angle of the mouth, the result of the cicatrization of the former ulcers (*Hutchinson's lines*); 3, a peculiar conformation of the skull, the result of the previous bone-lesion, consisting chiefly in a furrow above the eyebrows, a square forehead, and prominent frontal eminences; and 4, a characteristic appearance of the permanent central incisor teeth, consequent upon the action of the stomatitis upon them while yet soft and uncut. The distinctive sign of syphilis in these teeth is a slight crescentic notch in the biting edge (Fig. 9). They are also generally dwarfed, especially in width, their angles are rounded off, and their sides convex in outline (*pegged teeth*). These appearances must be distinguished from those due to the action of mercurial stomatitis, the teeth so affected showing horizonal markings, or honeycomb-like excavations in the enamel (compare Figs. 9 and 10).

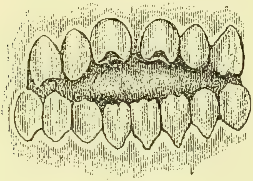

Fig. 9.—Syphilitic teeth (after Hutchinson).

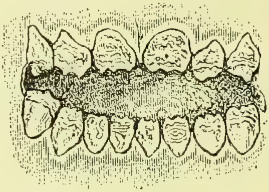

Fig. 10.—Mercurial teeth (after Hutchinson).

The bone-lesions of congenital syphilis were until recently overlooked, or confounded with those of rickets, which they much resemble. Two forms are described, the *osteophytic* and the *atrophic*. In the *osteophytic* the cranial bones present localized and symmetrical thickenings (*Parrot's nodes*) in the region of the frontal and parietal eminences (*the natiform or hot-cross-bun-like skull*), and the long bones subperiosteal enlargements. In the *atrophic* the cranial bones, especially in the occipital region, are thinned or locally absorbed, so that the brain is only covered at these spots by a thin membrane (*osteoporosis*, *craniotabes*), and the long bones are enlarged at their epiphyses by the production of ill-formed bone and the absorption of the normal bone. These lesions are usually transitory, and generally give rise to little inconvenience; but at times separation of the epiphysis may occur, with inflammation of the neighbouring joint; and when several bones are affected, the child may be so chary of movement on account of the pain it causes that infantile paralysis may be simulated.

Treatment.—In the early stages mercury generally acts like a charm. It is best administered as an inunction by putting half a drachm of blue ointment on the binder of the child and allowing it to be thus rubbed into the skin. Or it may be given in the form of mercury and chalk in doses of from half to one grain, but is then apt to cause diarrhœa. Mercury, however, should be given with caution if there is much marasmus, and discontinued as soon as the symptoms have cleared up, lest mercurial stomatitis be induced and the permanent teeth suffer in consequence (Fig. 10). The child should be well and carefully fed during the mercurial course, and small doses of cod-liver oil may often be taken with advantage. If the mother is unable to suckle the infant it must be brought up by hand, not by a wet nurse, for fear of her nipple becoming affected with a primary chancre, a danger the mother herself does not run, even although she has exhibited no signs of syphilis. This inability of an infant with inherited syphilis to infect its mother (known as *Colles' law*) was formerly thought to be a proof that the mother had suffered from syphilis whilst the fœtus was in utero. In some instances this has no doubt been the case. But in other instances she has shown no sign of syphilis during gestation, and there has been reliable evidence that she had not had the disease previously. The explanation offered by the followers of M. Pasteur is that the syphilis of the fœtus has protected the mother.

In the later stages of congenital syphilis, as in those of the cquired form, iodide of potassium is indicated, and may frequently e advantageously combined with small doses of mercury, where the ater lesions, as is too often the case, prove intractable. Lastly, hould syphilis be suspected in either of the parents during the eriod of gestation, mercury should be administered to the mother; hilst a caution should be given to both parents after the birth of a yphilitic infant for the sake of any future offspring.

HÆMOPHILIA.

HÆMOPHILIA, or the hæmorrhagic diathesis, is a condition in which bleeding is prone to occur spontaneously or on the slightest provocation, and is very difficult to arrest. The cause is unknown. The affection, however, appears to be hereditary; it often occurs in members of the same family, and nearly always in the males, although it is almost invariably transmitted through the female line. The pathology of the disease is obscure, but the arteries have been found thin, the left ventricle hypertrophied, and the different forms of leucocytes in the blood relatively altered in number. The bleeding may be started by the most trifling injury, such as a mere scratch of the finger, the extraction of a tooth, or a bite of the lip or tongue. Or it may occur spontaneously, when it is sometimes preceded by flushings of the face and throbbing of the arteries, and then commonly takes the form of epistaxis, or of extravasations beneath the skin, or of bleeding from the gums or intestines, or of effusion into a joint. When the result of a traumatism, the blood, except a large artery is wounded, oozes from the injured surface in a steady, continuous, and uncontrollable stream. The bleeding may last for weeks and then cease spontaneously, leaving the patient in an anæmic condition, from which, however, he may speedily recover; or it may terminate fatally. Successive attacks are common at varying intervals, and to one of these the patient generally succumbs. Should, however, he survive the period of puberty, there is a fair chance of the tendency to bleed decreasing with advancing years. The *treatment* consists in placing the patient at perfect rest in the recumbent position, and in applying a graduated compress, or tampon of perchloride of iron, and in elevating the part when the bleeding comes from a limb. Ligature, the actual and galvanic cautery and acupressure only do harm by increasing the size of the wound; and cold, in the form of ice, is of doubtful benefit. When the blood comes from a tooth-socket a plug of perchloride of iron may be applied. Internally, such drugs as ergotin, acetate of lead, gallic acid, and sclerotic acid, are recommended, but do not appear to have much power in controlling the bleeding. Calcium chloride (grs. 10 to 15) has been recommended internally, and as a local styptic, a solution of fibrin ferment to which calcium chloride has been added (see Styptics, p. 117). Wright has found that the internal use of chloride of calcium in a case of hæmophilia reduced the coagulation-time from ten to five seconds.

TUMOURS.

A TUMOUR, as generally understood, is a swelling not dependin upon inflammation or mere hypertrophy of pre-existing tissue, an showing no tendency to undergo spontaneous cure or to yield to the action of medicines. In *structure* a tumour consists of elements resembling those of the normal tissues of the body either in the mature or in the immature state. Thus a tumour may be composed of bone, cartilage, fat, &c.; or of cells like those constituting the epithelium; or of elements indistinguishable from the rudimentary tissues found in the embryo. A tumour may resemble and continue to grow in the tissue in which it originates, merely *displacing* the surrounding tissues, as for example, a fatty tumour growing in the subcutaneous fat. It is then called *homologous*. Or a tumour may originate in one tissue, and retaining the type of that tissue, invade and replace another, as an epithelioma infiltrating connective tissue, muscle, or bone; it is then spoken of as *heterologous*. Homologous tumours have generally the structure of the mature tissues of the body, as fibrous tissue, fat, bone, &c., and are usually innocent. Heterologous tumours, on the other hand, often consist of cells like those of a rapidly growing tissue, and are generally malignant. The more cellular the organization of a tumour the greater, as a rule, is its malignancy, although, as pointed out by Mr. Butlin, ‘ tumours of similar structure differ widely in their power of mischief according to the part of the body in which they originate.’

Development.—All tumours are believed to arise by the multiplication of pre-existing cells, and to retain throughout their growth the type of the cell from which they spring; hence they are spoken of as connective-tissue or as epithelial growths, according as they originate in the connective tissue or in the epithelium. Tumours arising in the connective tissue may at first consist entirely of small round cells, with a scanty amount of intercellular substance; that is, they resemble young connective tissue. They may retain this structure throughout their course (*sarcoma*), or they may become more highly developed and assume the structure of the more specialized connective tissues. Thus, fibrification may occur and the tumour take the form of mature fibrous tissue (*fibroma*); or chondrification or ossification may ensue, or fat be deposited in the cells, and the tumour become indistinguishable in structure from normal cartilage, bone or fat (*enchondroma, osteoma, lipoma*). Tumours springing from epithelium not only retain the character of epithelium, but likewise that of the special form of epithelium from which they are derived. Thus they resemble squamous epithelium when derived from the skin, spheroidal epithelium when from a gland.

Cause.—Little is actually known of the etiology of tumours. Some forms however, appear undoubtedly to be due to *local causes*, such as—1, long-continued irritation; 2, chronic inflammation; and 3, injury; but whether these conditions are in themselves capable of producing tumours unless the patient is otherwise in some unknown way predisposed to tumour-formation is still perhaps open to question. The presence in the completely developed tissues of embryonic remains which from some unexplained cause have taken on active growth later in life, is also regarded by some pathologists as a cause. This view is, however, untenable, so far as carcinoma is concerned, since cancer always begins in highly differentiated epithelium, and never reverts to an embryonic undifferentiated type. Thus a squamous epithelioma often arises in the larynx from epithelium which, although originally columnar, through irritation has become squamous. The question, however, of greatest interest at the present time is that of the infective nature of the cancers. So far no one has succeeded in inoculating the disease from man to animals, nor from animal to animal of the same species, except by actually grafting a portion of the growth, and no specific micro-organisms of the nature of a bacillus or micrococcus have been discovered by cultivation-experiments. In the epithelial cells of the carcinomata, however, peculiar bodies have been found, and are believed by their discoverers to be of the nature of protozoa, and similar to the psorosperms present in the epithelial cells in coccydiosis, a parasitic disease of rabbits. Whether these cancer bodies are of the nature of protozoa as maintained by their discoverers is open to dispute. Some of them, at any rate, thus described have been proved to be degenerations of the epithelial cells or degenerations of the nuclei. The arguments for and against the view of the parasitic nature of cancer cannot be here discussed. Although it would appear that no true spores have as yet been demonstrated, and it has been proved that cancer cannot be inoculated, it is possible that the parasite, if such exists, may need for its further development, as do the protozoa of some other parasitic diseases, special conditions outside the body of its host. The fact that cancer is endemic in certain localities seems to lend some support to the idea that it may be of miasmo-parasitic origin. Mr. D'Arcy Power, who has been doing excellent work on this subject, declares himself an unbeliever in any of the cancer bodies which have yet been discovered, and believes his experiments shew that they are merely the result of chronic inflammation upon the epithelium. It may be said indeed that the protozoal view of cancer has now been generally abandoned. A still more recent view, which is also likely to disappear soon, connects cancer with certain yeast-forms.

Tumours have further been ascribed to such *constitutional* causes as hereditary predisposition, the activity of tissue-growth in early life, the slow degeneration of advancing age, and the lessened resisting power of the tissues that may be occasioned by such depressing influences as grief, anxiety, or mental strain. Residence in certain localities is considered by some observers to be a predisposing cause of some forms of malignant tumour.

Clinical course.—Clinically, tumours are spoken of as innocent and malignant. I. *Innocent tumours*, as a rule, grow slowly, and resemble the fully-formed tissues of the body, and usually those amongst which they grow. They are generally encapsuled, circumscribed, and freely moveable, merely *displacing* the tissues around, not infiltrating them. They do not involve the lymphatic glands, nor become disseminated in distant organs; neither do they recur if completely removed. They may, however, attain a large size and destroy life by pressing upon a vital organ, or in other ways interfering with its functions. II. *Malignant tumours*, on the other hand, grow rapidly, do not resemble the fully-formed tissues in structure, and differ markedly in appearance from the tissues in which they grow. They are generally non-encapsuled and infiltrate and replace the surrounding parts, whether these be muscle, fat, bone, &c., and in consequence become more or less fixed and adherent. They frequently involve the lymphatic glands, and become disseminated through the body by means either of the lymph- or blood-stream. They usually recur after removal, in the scar, in the corresponding lymphatic glands, or in internal organs, and sooner or later give rise to a general cachectic condition known as the *cancerous cachexia*. Death is commonly due to exhaustion caused by the local ulceration, hæmorrhage and pain, combined with the mental distress, and the general interference with nutrition induced by the rapid growth of the tumour and its dissemination through internal organs.

Secondary changes are common in tumours, especially in those of more rapid growth. Thus a tumour may become inflamed, or may ulcerate, or undergo fatty, mucoid, colloid, pigmentary, or calcareous degeneration; or as the result of these changes, or of hæmorrhage into its substance, cysts, or, more rarely, circumscribed abscesses, may form in its interior; or the whole tumour may undergo necrosis, and, in exceptional instances, slough away.

Recurrence and dissemination.—Local recurrence is probably the result of some of the tumour-elements having escaped removal, and may take place in the scar, or in the tissues immediately around. Reproduction in the neighbouring lymphatic glands is believed to be due to the tumour-cells becoming arrested in the lymph-sinuses; dissemination in more distant tissues and organs to the tumour-cells being carried by the blood-stream (which they may enter either directly, or indirectly by the lymph-channels) to these parts, where they become lodged, and form starting-points for secondary growths. Secondary growths, whether in the glands, or elsewhere, resemble in structure the primary tumour.

Classification.—Tumours are here classified according to their anatomical structure. Thus, they may be divided into:—

I. *Connective-tissue tumours*, which are such as spring from the connective tissue. These may be subdivided into :—A. Those of the type of fully-formed connective tissue, *i.e.*, fibrous, fatty, cartilaginous, osseous, and mucous tissue : (1) *Fibroma*, (2) *Lipoma*, (3) *Enchondroma*, (4) *Osteoma*, (5) *Myxoma*, and (6) *Papilloma*. B. Those of the type of the higher complex connective tissues, *i.e.*, muscle, nerve, blood-vessels, lymphatic vessels, and lymphatic glands : (1) *Myoma*, (2) *Neuroma*, (3) *Angioma*, (4) *Lymphangioma*, and (5) *Lymphadenoma*. C. Those of the type of young connective tissue : (1) *Round-celled sarcoma*, (2) *Spindle-celled sarcoma*, (3) *Giant-celled* or *Myeloid sarcoma*.

II. *Epithelial and glandular tumours*, which are such as are mainly composed of cells like epithelium. They are divided into :—A. The innocent : (1) *Adenoma ;* and B. The malignant : (1) *Spheroidal-celled carcinoma* ; (*a*) *Hard* or *Scirrhous carcinoma ;* (*b*) *Soft* or *Encephaloid carcinoma* ; and (*c*) *Colloid carcinoma*. (2) *Squamous-celled carcinoma* (*epithelioma*), and (3) *Columnar-celled or cylindrical carcinoma*.

III. *Teratoma*, a rare form of tumour, containing bone, hair, teeth, or fragments of the viscera of a suppressed fœtus.

I. CONNECTIVE-TISSUE TUMOURS.

A. *Tumours of the type of fully-formed connective tissues.*

FIBROMATA OR FIBROUS TUMOURS consist of fibrous tissue, which may vary in density from the firmness of a tendon or ligament to the soft consistency of the subcutaneous tissue. They are quite innocent, grow slowly, do not return if completely removed, and are usually surrounded by a distinct capsule.

Structure.—The firmer varieties (Fig. 11) consist of dense fibrous tissue intermixed with but few elastic fibres and connective-tissue corpuscles. The fibres, as a rule, are variously interlaced without definite arrangement, though in some fibromata they form concentric circles around the blood-vessels. On section they appear firm, smooth, and glistening, and of a greyish-white colour. The vessels are usually small, thin-walled, and not numerous, though certain of the fibromata (*naso-pharyngeal polypi*) are very vascular, and are permeated by large cavernous blood-spaces. The *softer varieties*, formerly called fibro-cellular tumours, consist of loose succulent fibrous tissue, and often contain large and numerous blood-vessels. On section they appear yellowish, glistening, semi-transparent, and gelatinous, and a serous fluid can be squeezed out from the cut surface.

Secondary changes.—Calcification, ulceration, and mucoid softening.

Usual seats.—Fibromata may grow from the connective tissue anywhere, but the harder forms are chiefly met with in the periosteum, especially that of the jaws (*fibrous epulis*), in the uterus, where they are intermixed with unstriped muscle (*myo-fibroma*), in the neurilemma of nerves (*false neuroma*), on the termination of nerves (*painful subcutaneous tumour*), and in the naso-pharynx and rectum (*fibrous polypus*). The *softer* forms grow from the subcutaneous and submucous tissue, and the intermuscular septa, and are most frequently met with in the scrotum, labium, and scalp. The loose textured, large and often pendulous growths, occurring in the subcutaneous tissue, and known as *wens*, and the small, sessile, or partially-pedunculated tumours scattered over the body in the condition known as *molluscum fibrosum*, are varieties of soft fibromata.

The *signs* and *diagnosis* of fibromata vary according to their situation, and will be again referred to under the diseases of the various regions in which they occur. The firm fibromata are usually oval or globular, smooth, painless unless attached to a nerve, moveable, very firm and hard, and generally single. The softer forms are smooth, globular, elastic, soft and painless, especially when growing about the scrotum or labium; doughy, non-elastic, moveable, pendulous, and fleshy when occurring as wens.

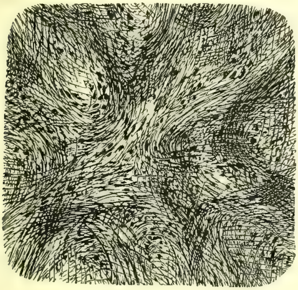

Fig. 11.—Fibrous tumour. Firm variety.

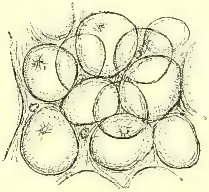

Fig. 12.—Fatty tumour

Treatment.—When practicable they should be removed.

Lipomata or fatty tumours are composed of fat like that normally found in the body. They are innocent, and grow slowly, but may attain a large size, and do not return on removal. They are most common in adult life.

Structure.—They consist of masses of fat bound together by delicate connective tissue and blood-vessels, and are surrounded, as a rule, by a thin capsule, which is attached by fibrous septa to the skin. The microscopical characters are seen in Fig. 12.

Secondary changes.—Mucoid softening, inflammation with adhesion from pressure, and, very occasionally, ulceration and calcification.

Usual seats.—They are most common on the shoulders, back, and nates, where they have been attributed to irritation or pressure, as by the braces, the sitting posture, &c.

Signs and diagnosis.—They form circumscribed, lobulated, semi-fluctuating, painless, soft, inelastic tumours, generally single, but occasionally multiple. They may be distinguished from a chronic abscess, a bursa or a cyst, the swellings for which they are perhaps most likely to be mistaken, by the edge slipping from under the fingers when the side of the tumour is pressed upon, by the dimpling of the skin when pinched up between the thumb and fingers, and by the non-escape of fluid on puncture with a grooved needle. They sometimes, when gravity favours it, shift their site by slipping down in the connective tissue. This is most common in the spermatic cord, a lipoma there having a tendency to sink down into the scrotum. A *diffuse* variety of lipoma is sometimes met with in the form of symmetrical masses of fat at the back of the neck and below the chin. This variety is mostly seen in stout men above middle age, and especially in those who are addicted to alcohol.

Treatment. — The capsule should be freely opened, when the tumour will usually readily shell out. The diffuse form should be left alone; for such, liquor potassæ in small doses for long periods may be tried. I have certainly seen these tumours get smaller under its use.

ENCHONDROMATA, OR CARTILAGINOUS TUMOURS consist of cartilage, and are always innocent, grow slowly, and do not return on removal. Cartilage, however, is frequently developed in sarcomatous tumours, and it is probable that the malignancy which enchondromata have at times apparently exhibited may have been due to the presence of sarcoma elements which were overlooked.

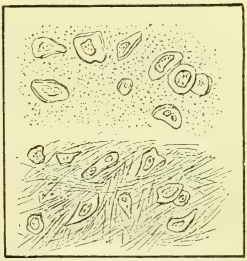

FIG. 13.—Cartilaginous tumour. Upper half hyaline; lower half fibrous.

Structure. — Cartilaginous tumours are encapsuled, and, when large, are often lobulated. They may consist of a single mass of cartilage, without visible partitions, or of numerous small clustered masses bound together by connective tissue and blood-vessels. On section they are translucent, bluish-grey, pinkish-white, homogeneous or coarsely granular, and frequently mapped out into irregular lobules. They usually consist of hyaline or fibro-cartilage. The microscopical characters of typical examples of the hyaline and fibrous varieties are seen in Fig. 13.

Secondary changes.—Calcification, ossification, mucoid softening with formation of cysts, and ulceration.

Usual seats.—The bones, especially the phalanges of the fingers and sometimes of the toes, the lower end of the femur, and the head of the tibia and humerus. Tumours containing cartilage also occur in the parotid gland and testicle, but these tumours are generally chondrifying sarcomata, not pure enchondromata.

The *signs and diagnosis* will be given under Tumours of Bone. Here only need it be said, that their chief characteristics are their extreme hardness, smooth or lobulated surface, and slow and painless growth. They are usually single, except in the hands, where generally several fingers are affected. At times they are of a softer consistency in places owing to mucoid softening, and at times of rapid growth, but in the latter case it is probable that they contain sarcomatous elements. Although they may occur at any age, they are most common in the young.

Treatment. — They should be removed, where possible, by enucleation.

OSTEOMATA OR OSSEOUS GROWTHS consist of true bone. They very rarely occur except in connection with bone or cartilage, and will again be referred to under Diseases of Bone. Those growing in connective tissue apart from bone are probably other tumours, or structures such as cysts, tendons, and muscles, that have undergone calcification or ossification.

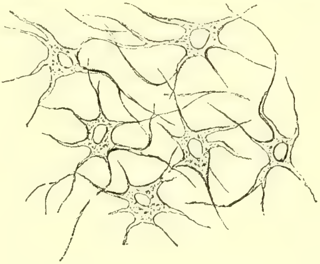

Fig. 14.—Myxomatous tumour.

MYXOMATA OR MUCOUS TUMOURS consist of tissue resembling that found in the umbilical cord and vitreous humour of the eye; but many of the growths that were formerly claimed as myxomata would appear to be fibromata, sarcomata or enchondromata undergoing mucoid softening. Pure myxomata are innocent tumours and do not return if completely removed, but they may attain a large size.

Structure.—They consist of a soft gelatinous semi-translucent material, enclosed in a loose capsule of connective tissue, and intersected by bands of fibrous tissue. On section, they are of a pinkish or yellowish-grey colour, and of a soft gelatinous consistency, often almost diffluent; whilst a tenacious and glairy fluid containing large quantities of mucin oozes away from the cut surface. Under the microscope there are seen round and spindle cells and stellate cells with branching processes, the processes forming a delicate stroma in the meshes of which the homogeneous, gelatinous basis-substance is contained (Fig. 14). The round and spindle cells vary in number, and are not shown in the diagram. Fibrous tissue, fat, cartilage, and sometimes adenomatous and sarcomatous elements may likewise be present; but it is questionable in these cases whether the tumour should not be regarded as a soft fibroma, lipoma, enchondroma, sarcoma, &c., undergoing mucoid degeneration.

Secondary changes.—Fatty degeneration, inflammation, ulceration, and the formation of blood-cysts owing to rupture of the capillary vessels.

Usual seats.—They are most often found in the nose, where they constitute the gelatinous polypus. They are also found in the adipose, subcutaneous, submucous, and subserous tissue, and occasionally in the periosteum and medulla of bone and neurilemma of nerves.

Signs.—Except when forming polypi, as in the nose, they resemble fatty and soft fibrous tumours, from which they cannot be diagnosed with certainty. The so-called gelatinous or mucous polypus will again be referred to under *Diseases of the Nose.*

Treatment.— Removal where practicable.

PAPILLOMATA or WARTY and VILLOUS TUMOURS resemble in structure the papillæ of the skin and mucous membrane. They include warts, condylomata, and mucous tubercles, and some forms of so-called villous tumours. They are innocent growths, rarely attain a large size, and only occur in the skin and mucous membrane. In old people, however, warty growths are apt to become epitheliomata, *i.e.*, the surface epithelium grows into the depth of the papillæ and becomes cancerous; and villous growths in the bladder may destroy life by the hæmorrhage to which they frequently give rise.

Structure.—They all agree in that they resemble hypertrophied simple or compound papillæ. Thus, they consist of several layers of connective tissue surrounding one or more central blood-vessels, and are covered by one or more layers of epithelium resembling that natural to the part from which they spring. The epithelium however, never penetrates the connective tissue—a point that serves to distinguish them pathologically from epithelioma, which in many respects they resemble in structure. The *warts and warty growths*, which form circumscribed tumours or cauliflower-like masses often of considerable size, consist of enlarged papillæ covered with several layers of horny epithelium, and contain, as a rule, only a few small blood-vessels. The *condylomata* and *mucous tubercles*, which occur as flattened elevations of the skin and mucous membrane respectively, also consist of enlarged papillæ, but the epithelium covering them is moist and sodden, and the connective tissue, as might be expected from their rapid growth, is abundantly infiltrated with small round cells. They are always the result of syphilis. The *villous tumours*, which form delicate branching growths resembling the villi of the chorion, are also classed by some pathologists as papillomata, even when they grow from parts as the interior of the bladder where it is stated no papillæ normally exist. In such situations they spring from the sub-epithelial connective tissue, and owe their papillary shape to the arrangement of the connective tissue and epithelium around the blood-vessels. The latter are often dilated and numerous, and frequently give way, leading to serious hæmorrhages. The epithelium covering them forms a delicate layer, and may often be rubbed off or washed away by the urine.

Usual seats.—Papillomata in the form of warts and warty growths are of most frequent occurrence in the skin, especially of the hands and genital organs, and in the larynx. As condylomata and mucous tubercles, they occur about the anus and genitals, and on the mucous membrane of the mouth and throat. The villous growths are met with in the bladder, rectum, and larynx.

Secondary changes.—Pigmentation, ulceration, and atrophy. As age advances, the epithelium in the case of the warty growths is liable to invade the underlying connective tissue, the papilloma being thus converted into an epithelioma.

The *signs*, *diagnosis*, *and treatment* of the different varieties of papillomata are given under the heads of skin, syphilis, bladder, rectum, and larynx. All that need be said here is that warty growths, especially in some situations, as about the genitals, may greatly resemble epithelioma, from which, however, they may generally be distinguished by the absence of induration at their base, slower growth, non-implication of the glands, the probable history of venereal disease, and by their occurrence usually at an age younger than that at which epithelioma is commonly met with.

B. *Tumours of the type of the higher connective tissues.*

The *myomata* or muscle tumours consisting of non-striated or even of striated muscular fibres ; the *neuromata* consisting of true nervous tissue, either the grey or the white; the *angiomata*, or nævi; the *lymphangiomata* consisting of dilated lymphatics, and the *lymphomata* and *lymphadenomata* consisting of lymphatic glandular tissue, will receive no further attention here (see *Nœvi*, *Diseases of Nerves and Lymphatics*). Unstriped muscle tissue, it may be said, however, is frequently found in the so-called fibroid tumours (*myofibromata*) of the uterus, of which, indeed, it often forms the chief part. It is also found in the chronically enlarged prostate.

C. *Tumours of the type of young connective tissue.* (*Sarcomata.*)

SARCOMATA constitute a group of tumours resembling in structure immature connective tissue. They include the fibro-nucleated, fibro-plastic, myeloid, and recurrent fibroid tumours, and many of the so-called cancers of the older pathologists. Normal cellular connective tissue in the course of development may become fibrous tissue, cartilage, bone, &c. The sarcomata may, however, retain the structure of young connective tissue throughout their life-history; and although in places, and indeed, in some instances in the greater part of the tumour, development may proceed, as in the normal growth of the body, to the formation of fibrous tissue, cartilage, or bone, yet the circumferential or growing parts of the tumour will always be found to consist of sarcoma elements. Hence the importance of examining a growing part lest a sarcoma which has undergone chondrification, ossification, &c., be pronounced a cartilaginous or osseous tumour. The sarcomata present the most diverse characters, both as regards their structure and their clinical behaviour, but have the following in common:—1. The cells of which they are composed consist of masses of protoplasm without distinct cell-wall, and contain one or more nuclei. 2. Each cell is surrounded by a varying amount of intercellular substance which has no definite arrangement, and does not form alveolar spaces as in carcinoma. 3. The blood-vessels have very thin walls, and ramify among the cells, not in the stroma as in carcinoma; indeed, they are often mere spaces bounded by the cells themselves; hence the frequency with which hæmorrhages occur in the substance of the growth. 4. Dissemination usually takes place by the blood-vessels (not by the lymphatics, as in carcinoma), a fact which may probably be explained by the above-mentioned relation of the vessels to the cells. 5. The secondary growths, when dissemination occurs, are, as a rule, like the primary, and are most frequent in the lungs. 6. Sarcomata grow by invading the surrounding tissue, and generally return locally after removal, probably because some portion of infiltrated tissue has been left. 7. They do not, as a rule, affect the lymphatic glands, except when they occur as primary tumours in such glands, or invade glands from surrounding parts, or when they grow from the periosteum, or in the testis and tonsil, when implication of the glands is the rule rather than the exception. 8. They are of most frequent occurrence in youth and early middle life. 9. Their cut section, when fresh, does not yield a milky juice like that obtained on scraping a carcinoma.

In their simplest form sarcomata consist of small round cells resembling, but very distinct from, leucocytes, embedded in a scanty amount of homogeneous intercellular substance traversed by delicate loops of capillary vessels; in fact they so closely resemble the granulation-tissue of inflammation as to be often microscopically indistinguishable from it. In the higher forms the cells become elongated and of a spindle shape, and the intercellular substance may show an attempt at fibrillation; or fibrification, chondrification or ossification may ensue, and indeed in some instances may proceed to such an extent that the whole tumour appears composed of fibrous tissue, cartilage, or bone, and it may only be at the growing edge that the sarcomatous elements are discoverable. Notwithstanding such changes the tumour will continue to display its malignancy in that it still invades the surrounding tissues, or becomes disseminated through internal organs. Sarcomata that have thus undergone ossification are often spoken of as *ossifying sarcomata.* Ossification, however, is seldom met with except in sarcomata in connection with bone, and although it may then occur in all varieties, is most common in the spindle-celled and mixed forms. The new bone-spicula usually grow into the tumour at right angles to the shaft of the bone, and are surrounded by sarcoma tissue; whereas in the true osteomata the bone-spicula are parallel to the shaft, and are surrounded by cartilage or periosteum.

Sarcomata may be divided into four chief groups (*a*) the *round-celled*, (*b*) the *spindle-celled*, (*c*) the *giant-celled* or *myeloid*, and (*d*) the *mixed-celled*.

(*a*) The ROUND-CELLED SARCOMATA usually occur as soft vascular and very rapidly-growing tumours, and often attain a large size, and quickly become disseminated through distant parts of the body and through internal organs.

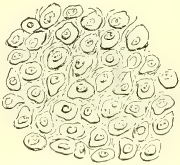
FIG. 15.—Round-celled sarcoma.

Structure.—They consist of round cells, varying in size in different tumours, and embedded in a small amount of granular or homogeneous intercellular substance. On section they appear soft and vascular, resembling brain matter. Hence the term *encephaloid* or *medullary* which is sometimes applied to them. It was this variety of sarcoma that was formerly called *encephaloid cancer.* The microscopical appearance of a typical specimen is shown in Fig. 15.

Secondary changes.—They may undergo mucoid softening, fatty degeneration or ulceration, or blood may be extravasated in their substance, leading to the formation of cysts (*sarcomatous blood-cysts*).

Usual seats.—Wherever fibrous tissue exists; but they are most common in the periosteum, bone, skin, subcutaneous tissue and testicle.

Varieties of round-celled sarcoma.—1. The *glio-sarcoma*, which grows in the connective tissue of the brain and nerves, and has a matrix like that of the neuroglia of nerve-centres. It occurs most frequently in the retina and brain. 2. The *lympho-sarcoma*, which grows in the lymphatic glands. It consists of a reticulum resembling ymphoid tissue, and of small round cells usually of the size of ymphocytes. 3. The *psammoma*, a very rare form which occurs in the pineal body and orbit, and has been met with in the meninges and ovary, is by some pathologists classed with the endotheliomata. It contains varying amounts of calcareous matter. 4. The *alveolar sarcoma*, in which the matrix forms a net-work enclosing each cell in a separate space or alveolus. 5. The *melanotic sarcoma*, which contains pigment both in the cells and intercellular substance. Its favourite seat is in the skin and the choroid coat of the eye—*i.e.*, in the situations where pigment normally exists. It becomes rapidly disseminated through the body, the secondary growths being generally also pigmented. It is the most malignant of the sarcomata, and was formerly known as *melanotic cancer*. The cells are sometimes spindle-shaped instead of round. It differs from the pigmented wart, in that the latter is firm, often pedunculated or lobulated, and of slow growth.

The *signs* of round-celled sarcomata vary so much according to the tissue implicated that only the briefest outline of their general course can be here given. They will more especially be referred to under bone, testicle, and breast. Here it may suffice to say that they exhibit all the signs of malignancy. Thus they grow rapidly, invade the surrounding tissues, the veins over them become enlarged, and the skin as they approach it becomes inflamed, and finally gives way, and an ulcerating chasm is left or a fungus protrudes. The health and strength fail, cachexia sets in, evidence of dissemination of the disease in other tissues or in internal organs may be manifested, and death soon ensues.

Diagnosis.—It is often very difficult to diagnose a sarcoma, especially of bone, from the inflammatory affections. The history of the case, the unequal consistency of the tumour, which may be hard in places, soft in others, the irregularity of its shape, the absence of pus on puncture with a grooved needle, and the progressive loss of weight and strength point to its sarcomatous nature; but an incision into it will sometimes be necessary to clear up the doubt. The rapid growth and dark colour of a melanotic sarcoma are distinctive.

Treatment.—The only effectual treatment is removal. When the tumour is situated in one of the extremities amputation well above the disease should be practised; when on the trunk it should, where practicable, be dissected out, cutting as wide of the disease as possible.

(*b*) THE SPINDLE-CELLED (Fig. 16) are the most common of the sarcomata, and are composed of spindle-shaped cells, varying in size, and containing one or more nuclei. The cells, in some instances, are arranged concentrically around the blood-vessels, or in bands; or again, in other instances, appear to have no definite arrangement. Spindle-celled sarcomata are subdivided according to the size of their cells into the small-spindle-celled and large-spindle-celled variety.

The small-spindle-celled sarcomata are firmer and less rapid in their growth than the round-celled or large-spindle-celled forms; they do not become so quickly disseminated in internal organs, and are therefore less malignant. They generally recur locally when removed; but after many recurrences, their tendency to return may at length cease, or they may, on the other hand, assume a more malignant form and become disseminated.

Structure.—They consist of small spindle cells containing usually a single nucleus; the cells are embedded in a small amount of homogeneous intercellular substance, which at times is somewhat fibrillated. They may at first be enclosed by a capsule, but later infiltrate the surrounding parts. They appear as smooth firmish growths, pinkish-white, semi-translucent, and fibrillated on section. Their microscopical appearance is seen in Fig. 16. *Secondary changes.*—Fibrification, chondrification, calcification, ossification, and, when implicating the skin, ulceration. *Usual seats.*—Periosteum, fasciæ, and subcutaneous tissue.

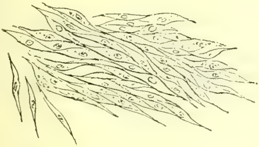

Fig. 16.—Spindled-celled sarcoma.

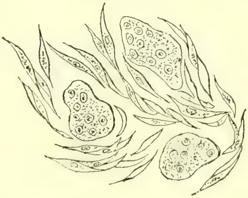

Fig. 17.—Myeloid sarcoma.

The large-spindle-celled sarcomata are much softer than the preceding variety, and often grow rapidly, and quickly become disseminated; indeed, they may be as malignant as the round-celled growths. *Structure.*—They consist of large spindle cells, which frequently contain several oval nuclei, embedded in a scanty amount of intercellular substance. They occur as non-encapsuled tumours of soft consistency, frequently in parts diffluent, and on section appear of a pinkish-white colour, and often blotched with blood. *Secondary changes.*—Fatty degeneration, blood-extravasation with the formation of blood-cysts, and ulceration. *Usual seats.*—The intermuscular fasciæ, periosteum, and breast.

Signs and diagnosis.—The small-spindle-celled sarcomata, when occurring in the fasciæ and subcutaneous tissue, appear as moderately firm, or at times as softer growths, unattended with signs of inflammation unless involving the skin. They recur *in situ* after removal, but do not as a rule become disseminated. The large-spindle-celled forms resemble the round-celled, from which they cannot be distinguished before removal. Both varieties are more especially referred to under *Diseases of Bone.*

Treatment.—The small-spindle-celled variety should, where practicable, be freely and widely removed. The treatment of the large-spindle-celled is like that of the round-celled.

(*c*) THE GIANT-CELLED OR MYELOID SARCOMATA most frequently occur in connection with bone, and are the least malignant of the sarcomata. It has been recently asserted that they are only met with in the red marrow of bone, and are not malignant. Dr. Kanthack has seen them, however, where there is yellow marrow or no marrow at all, as in the skin, breast and elsewhere. They are usually of slow growth, especially when occurring in the interior of the long bones, and after removal seldom recur; they are said, however, to have been followed by malignant forms.

Structure.—They consist of spindle or round cells, amongst which are found large irregularly-shaped masses of protoplasm, containing often as many as thirty or forty oval, highly refracting, distinct nuclei. These masses of nucleated protoplasm are known as *giant* or *myeloid* cells, because they somewhat resemble those found in the marrow of the fœtus. The real prototype, however, is the giant cell of the connective tissue. The microscopic appearance is seen in Fig. 17. Myeloid sarcomata vary from a firm or fleshy to a soft or jelly-like consistency, and are neither elastic nor tough. On section they appear uniformly smooth, succulent, shining, semi-translucent, but not fibrillated, of a livid crimson or maroon colour not unlike the muscular tissue of the mammalian heart, and often blotched with brighter patches of pink or darker red, due to blood-extravasation.

Secondary changes.—Chondrification sometimes occurs, but ossification is rare. Blood-cysts are very common, from the giving way of some of the numerous thin-walled vessels.

Usual seats.—In the interior of the ends of the long bones, especially the lower end of the femur and upper end of the tibia, and in the upper and lower jaw.

Signs, diagnosis, and treatment.—See Sarcoma of Bone.

(*d*) THE MIXED-CELLED.—Many sarcomatous tumours consist of both spindle and round cells. They may resemble either the spindle-celled or the round-celled tumours, and cannot be distinguished without a microscopical examination.

Sarcomatous blood-cysts.—Soft sarcomatous tumours sometimes become completely broken down by extravasation of blood into their substance, and converted into cysts containing partly fluid and partly coagulated blood. When such a cyst is punctured, the hæmorrhage is often difficult to control. When cut into, the walls are generally found ill-defined, and it may be impossible to distinguish the cyst from a hæmatoma or ordinary blood-cyst without a microscopical examination of a piece of the wall.

II. EPITHELIAL AND GLANDULAR TUMOURS, OR TUMOURS OF THE TYPE OF EPITHELIAL TISSUES.

These may be divided into the innocent and the malignant.

(a) *The innocent.*

ADENOMATA OR GLANDULAR TUMOURS are innocent growths resembling secreting glands in structure, and only grow in connection with pre-existing glandular tissue. They are divided into the *acinous* and *tubular*, according as they resemble one or other of these glands. The *acinous variety* consists of acini, lined with spheroidal epithelium, and communicating with each other by duct-like channels. The acini are clustered in twos, threes, or more, and are separated and bound together by connective tissue, in which the vessels ramify. Pure adenomata are rare, the scanty amount of intertubular and interacinous connective tissue in such being more often replaced by fibrous tissue (*adeno-fibroma*), or by mucous tissue (*adeno-myxoma*), or by sarcomatous elements (*adeno-sarcomata*), or by a combination of two or more of the above tissues (*adeno-fibro-sarcoma*, *adeno-myxo-sarcoma*); whilst at times the acini or ducts become dilated into cysts, in which proliferating growths (*intracystic growths*) may project. The tumour is then spoken of as an *adeno-cystoma*, *cysto-sarcoma*, &c., according to the character of the intertubular and interacinous connective tissue. The microscopical appearance of an adenoma is shown in Fig. 18.

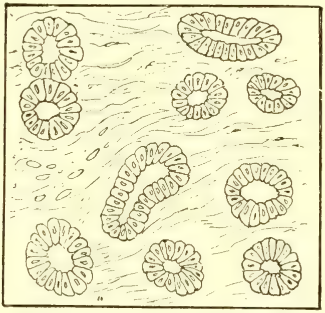

FIG. 18.—Adenomatous tumour.

The *tubular adenomata* resemble the tubular glands, the epithelium of this variety differing from that of the acinous in being more or less columnar. They are most common in the mucous membrane of the intestine, where they form papillary or polypoid growths.

Both varieties are distinguished from carcinoma, in that the epithelium does not penetrate the basement membrane and invade the connective tissue.

Usual seats.—The acinous occur in the mamma (where they are generally of the adeno-fibromatous form), the base of the tongue, the lip, the prostate, the thyroid, parotid, and lachrymal glands, and the sebaceous glands of the skin. The tubular occur in the intestine, especially the rectum.

Secondary changes.—Cystic degeneration consequent upon mucoid softening, and fatty degeneration of the epithelium.

Signs, diagnosis, and *treatment.*—See Diseases of the Breast, Rectum, &c.

(b) *The malignant.*

Carcinomata, or Cancers, are malignant growths consisting of epithelial cells contained in an alveolar stroma. The individual cells are not surrounded by any intercellular substance, as in the sarcomata, and the vessels run in the stroma, and not among the cells. They are derived from pre-existing epithelium. The epithelium is believed to proliferate and break through the wall of an acinus or duct, or the basement membrane of the skin or mucous membrane, and invade the surrounding or underlying connective tissue, where it is supposed to enter the lymphatic spaces, and thence, sooner or later, pass into the lymphatic vessels, and so finally become disseminated. The cells in carcinoma, though varying in their character, retain within certain limits the type of the epithelium from which they spring. Thus, they are more or less squamous when derived from the skin, squamous or columnar when derived from a mucous membrane, according to the character of the epithelium normally covering it, spheroidal when derived from a gland. The cells have recently been very minutely investigated by means of new methods of staining, and peculiar bodies, believed by some pathologists to be of the nature of parasites or protozoa, have been noted. These bodies, however, by other observers are held to be nothing more than phases of cell-degeneration depending upon chronic irritation or other causes. The alveoli in which the cells are contained are by many regarded as the lymphatic spaces natural to the affected tissue dilated by the invading epithelium, but this view is probably incorrect. The stroma surrounding the alveolar spaces at first consists of the connective or other tissue of the invaded parts, infiltrated more or less with small round cells. This small-cell-infiltration is ascribed to the irritation of the epithelial invasion, and from it is believed to be later derived the fibrous tissue constituting the dense stroma of some forms of carcinoma.

The blood-vessels, which run in the stroma, are numerous in the more rapidly-growing tumours, and especially in the circumferential parts, but are much fewer in number in the more chronic forms, and in the central parts of the latter may be obliterated by the growth of the fibrous tissue. Hence the frequency with which fatty degeneration of the cells, and breaking down (*ulceration*) of older parts of the tumour occur. In the softer or rapidly-growing forms, in which the stroma is scanty and the support that the vessels receive from it consequently but slight, hæmorrhages are frequent. Carcinomata have no capsules, grow by cell-division and continued invasion of the surrounding tissues, and, sooner or later, break down and ulcerate. They implicate the nearest lymphatic glands, and finally become disseminated. At first the general health is usually but little affected; but later, partly owing to the local ulceration and partly owing to the dissemination of the growth, a condition known as cancerous cachexia sets in, the skin becoming sallow and of a peculiar earthy colour, the face careworn and anxious, and the body emaciated. The strength fails, and the patient at length dies of exhaustion induced by the general interference with nutrition, local ulceration, hæmorrhages, pain and mental anxiety.

VARIETIES OF CARCINOMA.—The carcinomata are divided into three great classes:—(1) *The spheroidal-celled;* (2) *the squamous-celled* (epitheliomata); and (3) *the columnar-celled* or *the adenoid or glandular carcinomata.* The spheroidal-celled are further divided on clinical, rather than on pathological, grounds into (*a*) *the hard spheroidal-celled*, (*b*) *the soft spheroidal-celled*, and (*c*) *the colloid* variety, which is probably a degenerated condition of one or other of the former, or indeed of any variety of carcinoma, except the squamous-celled (epithelioma).

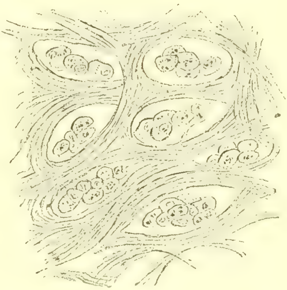
FIG. 19.—Hard spheroidal-celled or scirrhous carcinoma.

1. THE SPHEROIDAL-CELLED OR ACINOUS CARCINOMATA consist of epithelial cells resembling spheroidal or glandular epithelium, and only grow in connection with glands. They usually exhibit the characteristic alveolar structure of the carcinomata in a well-marked degree. They are divided into the hard spheroidal-celled, the soft spheroidal-celled, and the colloid varieties.

(*a*) *The hard spheroidal-celled carcinomata, the scirrhous or chronic cancers*, are moderate-sized, hard, nodular, and comparatively slowly-growing tumours, which, sooner or later, ulcerate and become disseminated through the body.

Structure.—They are characterized by the large amount of their stroma (Fig. 19). Indeed, the central parts of the growth, in some cases, consist of little else than dense fibrous tissue, with a few atrophied and fatty-looking cells in the shrunken alveoli. The circumferential parts of such tumours, however, still display the typical characters of acinous carcinoma, and in the surrounding tissues the epithelial invasion and the small-cell-infiltration are still going on. It is owing to the excessive formation of fibrous tissue that the scirrhous cancer is so hard, and creaks under the knife when cut; and to the tendency of the fibrous tissue to shrink, that the skin over the tumour becomes puckered and the nipple in the case of the mamma retracted, and that the cut surface of the tumour becomes concave.

Usual seats.—The breast; but scirrhous cancer also occurs in the pylorus, and more rarely, in other situations. The general appearance of scirrhous cancer, the symptoms, diagnosis, varieties and treatment, are given under Diseases of the Breast, its favourite seat.

(*b*) *The soft spheroidal-celled carcinomata, the medullary, encephaloid or acute cancers*, are much more rapid in their growth than the preceding variety, and form soft and often large tumours, quickly terminating in ulceration and general dissemination through the body. *Structure.*—The stroma is scanty in amount (Fig. 20), and does not contract like that of scirrhous; the cells, which are very prone to undergo fatty degeneration, are contained in large alveoli. These cancers are very vascular, and as the scanty stroma affords but little support to the vessels, extensive hæmorrhages into the substance of the growth are common. On section, they appear of a greyish-white or cream colour, blotched in places with blood, whilst in the centre they may be almost diffluent, consequent upon their having undergone fatty degeneration. On account of the resemblance to brain-matter the older pathologists termed them *encephaloid cancers.* After they have involved the skin, they protrude in the form of a bleeding fungating mass, and hence were further called *fungus hœmatodes.* Although in accordance with general usage the spheroidal-celled carcinomata are divided into hard and soft, it should be understood that histologically no hard-and-fast line can be drawn between them, as the characters of the one often merge into those of the other, so that sometimes it may be difficult to decide whether an individual spheroidal-celled carcinoma should be classed as hard or soft.

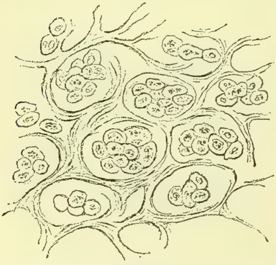

Fig. 20.—Soft spheroidal-celled or medullary carcinoma.

Usual seats.—The testis, liver, bladder, kidney, ovary, and breast. Secondary growths in internal organs consequent upon the dissemination of scirrhous cancer are often of the soft variety.

(*c*) *Colloid, or gelatiniform, carcinomata.*—These terms are applied to either of the above described varieties, or indeed to any form of carcinoma, which has undergone mucoid or colloid degeneration. It is believed that the degeneration generally begins in the cells which, as they become enlarged, so distend the alveoli that the latter can be seen by the naked eye. The colloid material is glistening, semi-translucent, and jelly-like, or in places diffluent. In it some spheroidal cells are generally found. The *favourite seats* of these cancers are the stomach, intestine, omentum and ovary; but they occasionally occur in the breast.

2. THE SQUAMOUS-CELLED CARCINOMATA (*Epitheliomata*) always spring from the skin or from a mucous membrane covered by squamous epithelium, and constitute the second great division of the cancers. They are characterized by the resemblance of their cells to squamous epithelium. The typical alveolar arrangement of the carcinomata is much less well marked than in the spheroidal-celled or acinous variety.

It was to this squamous-celled form of carcinoma that the term 'epithelioma' was originally applied; but as all carcinomas are now believed to be epithelial growths, the term 'squamous-celled' is prefixed to this variety to distinguish it from the columnar-celled and the spheroidal-celled carcinomata. Squamous-celled carcinomata may spring either from the skin or from any mucous membrane covered with squamous epithelium, and are especially common where skin and mucous membrane meet, as in the lip, anus, &c. They are most frequent in the old, seldom occurring under forty years of age, and are more common in men than in women. They are usually the result of continued irritation; thus in the tongue they may be due to the presence of a jagged tooth, in the lip to the constant contact of a hot pipe-stem, in the scrotum to the retention of soot or coal-tar in the folds of the skin. They are also not uncommon in situations where the epithelium is in an abnormal condition, as in old scars, white patches on the tongue and inner side of the cheek, chronic ulcers, warts, and moles.

Structure.—A squamous-celled carcinoma consists of solid columns of epithelium, which have perforated the basement membrane, and have grown into the connective or other underlying tissue. The columns are surrounded by an imperfectly fibrillated stroma and a small-cell-infiltration. This proliferation downwards of the epithelium into the connective tissue is common to many chronic irritative processes or growths of the skin, and by itself is not characteristic of epithelioma. In an epithelioma some of the epithelial cells become isolated and lie in the connective tissue away from the down growths. These isolated cells multiply and form masses of cells which become moulded into irregularly oval or round clumps, or may follow the lymph channels and thus distending them produce a network of solid epithelial tubules. But in any case, in this manner epithelial masses or cylinders arise which, lying in the depth of the tissue, are not continuous with the surface epithelium. From these masses and cylinders in turn epithelial cells become isolated, and from these isolated cells fresh cell masses are formed, so that in the connective tissue in the depth numerous islets of epidermal epithelium are found, so irregularly distributed that they cannot be traced to the surface, with which, as a matter of fact, once the growth has begun, they are never directly continuous. Both in the epithelial downgrowths and in the alveoli or islets in the depth are often found small collections of cells of a crescentic shape, arranged concentrically around one or more central rounded cells. These collections, generally spoken of as *cell-nests*, are horny pearls. They are built up from cells which originally were epidermal in character. The circumferential cells of a cell-nest are cylindrical, these are followed by cubical cells, and these again by narrow, curved or crescentic cells, arranged concentrically. The centre of the mass may consist of a glistening homogeneous or concentrically striated body devoid of nuclei which consists of horny matter. The structure of these nests, that is, their concentric arrangement and the cornification progressing from the centre to the periphery, depends on the fact, that the central and innermost cells are the oldest, while the peripheral ones, which at first show no tendency to become horny, are the youngest. Cell-nests and horny pearls may be absent, and when present are only then characteristic of carcinoma if they are imbedded in the depth discontinuous with the surface. Innocent papillomata frequently contain pearls, but then only in epithelial processes which are either directly continuous with the surface or can easily be traced to the surface. The epithelium of the surface of squamous-celled carcinoma is usually also proliferated outwards, forming a warty excrescence or cauliflower-like growth. Breaking down rapidly ensues, and an epitheliomatous ulcer is the result.

In the accompanying woodcut (Fig. 21), which represents the edge of a squamous epithelioma, the down-growing epithelial columns, a column in transverse section, and several cell-nests are seen.

Usual seats.—Tongue, lower lip, cheeks, gums, vulva, scrotum, penis and anus.

Signs.—A squamous-celled carcinoma usually begins as a warty tubercle, which soon becomes an ulcer with raised, everted, sinuous and indurated edges, and a hard, warty, and irregular base, whilst the tissues around become infiltrated with the growth and the nearest lymphatic glands enlarged. At other times it begins in a crack or fissure, and the ulceration keeping pace with the epithelial invasion, the margins of the ulcer are sharply defined, and may be undermined; or again the growth may have the appearance of a cauliflower-like mass of warts, often of horny consistency, projecting above the level of the surrounding skin. Unless an epithelioma is removed whilst the disease is still local, recurrence usually takes place in the nearest lymphatic glands; at times, like other forms of cancer, though less often, it may become disseminated through internal organs. When incompletely removed it will return in the scar. Death is usually the result of exhaustion consequent upon ulceration and hæmorrhage. The *signs*, *diagnosis*, and *treatment* are further referred to under Diseases of Regions. (See *Lip*, *Tongue*, *&c.*)

3. COLUMNAR-CELLED CARCINOMATA or CYLINDRICAL CARCINOMATA consist of cells derived from columnar or cylindrical epithelium, and are usually of slower growth than the former varieties. They often begin as papillary outgrowths from the surface of mucous membranes covered with columnar epithelium, or from the interior of the mucous glands, and are most common in the rectum, though they may affect other parts of the intestine, the uterus, &c. They may also occur in the breast as *duct cancers*.

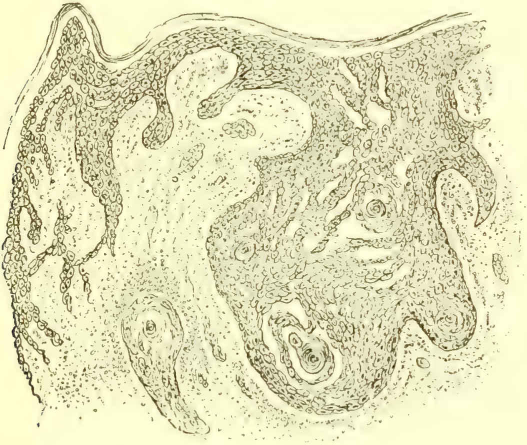

FIG. 21.—The growing edge of a squamous-celled carcinoma (epithelioma). (From Bowlby's Pathology.)

Structure.—They consist of irregular tubes or alveoli lined with columnar epithelium, and bound together by a delicate connective-tissue stroma more or less infiltrated with small round cells. The epithelial cells retain more or less their shape, and are arranged at right angles to the walls of the alveoli, generally leaving a central space. In the more rapidly-growing tumours, however, the alveoli become completely filled with the cells. Like other carcinomata they infiltrate the surrounding tissues, and may affect the lymphatic glands, and later become disseminated in internal organs, especially the liver. Death, however, usually occurs from obstruction of the bowel, hæmorrhage from the ulcerating surface, or exhaustion, rather than from dissemination. Their appearance, symptoms, diagnosis, and treatment are further described under *Tumours of the Rectum.*

THE TREATMENT OF CARCINOMA GENERALLY may be divided into the palliative and the radical. The *palliative* is resorted to when from some cause a cancer cannot be removed by operation, and consists briefly in soothing pain by opium, neutralizing the offensive smell when ulceration has occurred by antiseptics, and supporting the strength by nourishing diet and stimulants. The *radical* treatment aims at removing the cancer by operation, in the hope that it may not return or manifest itself in other parts. If removed early, there is a good chance of the squamous-celled carcinoma not doing so, and in some forms of the columnar and spheroidal-celled the same fortunate result occasionally occurs. As a rule, however, the issue is not so favourable, and after an immunity, varying in duration according to the variety, situation, and size of the tumour, the length of time it has existed, and the implication or non-implication of the lymphatic glands, the disease returns in the scar, in the lymphatic glands, or in internal organs. But though the patient may not be cured by an operation, he may be greatly relieved by the removal of the local trouble, and die with less distress from the implication of internal organs. Should removal be determined on, it is best done by the knife; but in certain parts the scissors or écraseur may be more applicable. At times caustics may be employed. Recently it has been urged that electrolysis is capable of so acting on the cancer cells as to prevent further growth and produce shrinking; but there is at present no trustworthy evidence that it has any such action. Injection of Coley's fluid, obtained by mixing the toxins of erysipelas with those of the *Bacillus prodigiosus*, has been apparently attended with some success in that the growth has diminished in size; but it is highly dangerous, and its use has been followed by fatal results, and to say the least is quite empirical. The various methods of removing carcinomata will be described more in detail under Diseases of Regions.

CYSTS.

A *cyst* is a closed sac containing fluid or pultaceous matter. Cysts may be divided into :—

I. *Cysts formed by distension of naturally-existing cavities or spaces.*
II. *Cysts of new formation.*
III. *Cysts of congenital origin.*

I. *Cysts formed by distension of naturally-existing cavities or spaces.*

These are subdivided into:—A. Exudation cysts; B. Retention cysts; and C. Extravasation cysts.

A. EXUDATION CYSTS are formed by exudation or by excessive secretion into cavities which have no excretory duct. Under this head are included Bursæ, Ganglia, Cystic bronchoceles, and Cysts in the ovary due to the dilatation of Graafian follicles. They will be further referred to under Diseases of Bursæ, Ganglia, &c.

B. RETENTION CYSTS are formed by the retention of the normal secretion and the consequent dilatation of the ducts or acini of the affected gland. They are lined with epithelium; their walls become thickened by fibroid changes; and the natural secretion is altered by inspissation or by exudation from the cyst-wall. Three forms are described—1, atheromatous or sebaceous cysts due to the dilatation of the sebaceous glands; 2, mucous cysts formed by the dilatation of mucous glands; and 3, cysts produced by the distension of special ducts, as the salivary, lacteal, hepatic, and renal ducts, and tubules of the testicle.

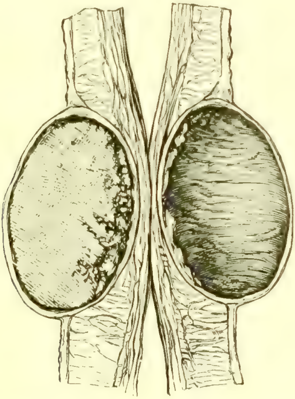

FIG. 22.—A sebaceous cyst divided into halves, and one half emptied of its contents. It is surrounded by a distinct capsule, and is situated in the skin proper superficial to the paniculus adiposus. (St. Bartholomew's Hospital Museum, No. 3,364 *c.*)

1. *Atheromatous* or *sebaceous* cysts (*wens*) (Fig. 22) occur mostly on the scalp or face, but may be met with on any part of the body, and are often multiple. They do not contain hair follicles, papillæ, or other skin elements, thereby differing from the dermoid cysts, which they otherwise resemble. Those on the scalp are sometimes hereditary. *Signs.*—They form smooth lens-shaped, semi-fluctuating,

moveable swellings, often adherent to the skin. They may be distinguished from a fatty tumour by not slipping from under the finger on pressing the edge of the swelling, and from an abscess by the absence of signs of inflammation. A small black punctum, the obstructed orifice of the sebaceous follicle, may, except in cysts of the scalp, generally be discovered on the surface. *Secondary changes.*—1. The contents of the cyst may undergo decomposition and become extremely offensive. 2. The cyst-wall may become inflamed and suppurate, and be thus cured, or a portion of the wall may escape and a sinus ensue, or the wound may heal and the cyst refill. 3. One part may give way, and the sebaceous matter exude, become hardened, and be pushed up from below, and take the form of a horny growth. 4. Granulations may spring up from the interior of the cyst, and exude as a fungating mass resembling an epithelioma. 5. They may degenerate into an epithelioma. 6. Their walls may undergo calcification. *Treatment.*—They may be removed by—(*a*) Dissection. (*b*) Splitting them, squeezing out the sebaceous matter, and seizing the cyst-wall with forceps and pulling it out. Care should be taken not to leave any of the wall behind, or a troublesome sinus will remain. (*c*) Dilating the orifice with a probe, and squeezing out the contents. They are apt, however, to refill when emptied in this way, unless the cyst-wall is also squeezed out or sufficient inflammation is set up to destroy it.

2. *Mucous cysts* are formed by the dilatation of mucous glands. They occur in the lips, mouth, labia, and other situations where mucous glands exist. In the mouth they constitute one form of *ranula*. The so-called dropsy of the antrum is generally believed to be due to the dilatation of one of the mucous glands of the lining membrane of that cavity, and the cysts met with at the entrance of the vagina to a dilatation of Bartholin's glands. The walls of mucous cysts are thinner than those of the sebaceous variety; the contents are viscid and mucoid in character, and chloresterine is at times present. *Treatment.*—Excision of a piece of the wall, and touching the interior with nitrate of silver or other caustic will generally cure them; if not, the cyst must be dissected out.

3. *Cysts formed by the dilatation of special ducts.*—As examples of these may be mentioned, dilatation of Wharton's duct (*ranula*), of a lacteal duct (*galatocele*), and of a tubule of the testicle (*encysted hydrocele*). For a further account, see Diseases of Regions.

C. EXTRAVASATION CYSTS are formed by extravasation of blood into closed cavities, as the tunica vaginalis of the testicle (*hœmatocele*), &c.

II. *Cysts of new formation.*

These are divided into—A. Serous cysts; B. Blood-cysts; C. Proliferous compound cysts; D. Implantation cysts; and E. Parasitic cysts.

A. Serous or simple cysts are thin-walled cysts, lined with a single layer of endothelium, and containing a sticky serous fluid. They are supposed to be formed by the accumulation of fluid consequent upon irritation, pressure, &c., in the lymphatic spaces of the connective tissue, these spaces subsequently becoming fused into a single cavity. Their walls consist of fibrous tissue formed by the condensation of the surrounding connective tissue by the pressure of the fluid. As examples of serous cysts may be mentioned:—adventitious bursæ developed over prominences of bone, some forms of ganglion, and simple cysts in the breast, neck, &c. By some pathologists, however, the serous cysts found in the neck are regarded as congenital formations. Those in the median line, except those arising in connection with the remains of the thyroglossal duct are undoubtedly formed by the enlargement of pre-existing bursæ, *e.g.*, those about the hyoid bone.

B. Blood-cysts or hæmatomata may be subdivided into—1. True blood-cysts, which are most commonly met with in the neck, and consist of thin-walled cysts containing pure blood. Their mode of origin is doubtful, but they appear to have some connection with the veins, since if tapped they often bleed very freely. 2. Cysts, formed by condensation of the tissues around a mass of extravasated blood. In such the blood may become absorbed or organized; or it may break down and disintegrate, or deposit fibrin upon the wall of the cyst; or suppuration may occur and an abscess ensue. They are common in the scalp (*cephalhæmatoma*), on the ear (*hæmatoma auris*) and in the arachnoid, but may occur in any situation after injury.

The extravasation of blood into serous cavities and into solid tumours is also by some included under Hæmatoma; but such a classification is misleading (see *Hæmatocele, Sarcoma*).

C. Proliferous compound cysts are cysts containing growths. They are most common in the breast and ovary, and will be found more fully described under Diseases of the Breast. These cysts are developed in connection with the growth of solid tumours, and must be distinguished from cystic degeneration, which, as has already been shown, is very common in some forms of tumour. In the one case, the cysts, which may be regarded as primary, contain growths springing from their walls or projecting into them from the growth around. In the other case, the cysts are secondary, and are produced by the degeneration and softening of the tumour-elements, or by the extravasation of blood into the substance of the tumour.

D. Implantation cysts, or traumatic dermoids, as they are sometimes called, are believed to be due to the intrusion of small fragments of epithelium through a punctured wound into the subcutaneous tissue, where they grow into a cyst. They occur most frequently in the palm of the hand as small painless rounded tumours, over which a cicatrix is often found. They contain sebaceous matter. Complete removal of the cyst-wall is essential.

E. PARASITIC CYSTS are such as are formed in the tissues around a parasite. *Hydatid cysts* only are here described; for an account of other parasitic cysts, the student is referred to a work on Pathology.

Hydatid cysts may occur in any of the tissues or organs of the body, but are most often met with in the liver. They are the cystic stage in the development of the cestode worm, known as the *Tænia echinococcus.* This worm in the mature form inhabits the intestine of the dog. Thence the ova may accidentally contaminate food or water, and so gain admission to the human intestine. The ova are then hatched, and the embryo may make its way by the portal vein to the liver, or by other channels to some other part of the body, where it becomes converted into a cyst. The cyst-wall (*endocyst*) is formed of an external *laminated* elastic layer and of a lining membrane, or *parenchymatous* layer, composed of cells, granules, muscle-fibres, and a water vascular system. Around the cyst a fibrous capsule (*ectocyst*) is formed as the result of the irritation of the connective tissue, and to this capsule the true cyst-wall is very loosely attached. The cyst is filled with a clear or slightly opalescent watery fluid containing chloride of sodium, usually hooklets and a trace of sugar, but no albumen. As the cyst enlarges, vesicles or *brood-capsules* are developed from the lining membrane, and in them *scolices*, or small cyst-like bodies furnished with four suckers and a crown of hooklets, are formed. From the brood-capsules secondary or *daughter* cysts may be developed, having the same structure as the primary or mother cyst, and in them again tertiary or *grand-daughter* cysts. At times the mother cyst does not contain any vesicles or brood-capsules, and is then called *sterile.* At other times, as in the shafts of bones, there may be no mother cyst, a condition known as *multilocular hydatids.* The cyst may (1) cease to grow, die, and be converted into a putty or mortar-like mass of tissue, undergoing in places calcification; (2) it may suppurate, or (3) burst spontaneously. *The signs* of an hydatid cyst of course vary according to the situation of the cyst. All that can be here said is that, when the cyst is in an accessible situation, it gives rise to a tense, elastic, more or less globular fluctuating swelling, of slow growth, in which, on percussion, a peculiar thrill may be felt, the so-called *hydatid fremitus.* Rupture or puncture may be followed by a diffuse erythematous or urticarious eruption. The *treatment* should be preventive and curative. *Preventive treatment.*—Seeing that the dog is infected by eating the offal of the sheep or pig, in which the worm resides in its cestode state, and that man is infected by food or water contaminated by the dog's excreta, which contain the ova of the tinea, the dog should be prevented from having access to such food, and an attempt should be made to destroy the worm and its ova. Thus, dogs should be purged and given anthelmintics, whilst their kennels should be scalded, and their excrement buried or burnt. All green food, as water-cress, that runs the risk of being fouled by dogs, should be well cleansed before it is eaten. *Curative treatment.*—The cyst should be removed entire where practicable. Where this is impossible, it should be incised, the contents evacuated, and the cavity drained, or better, the true cyst-wall should be shelled off the fibrous capsule, and the latter left to granulate. Aspiration or puncture is highly dangerous, especially in the case of abdominal hydatids. Although many cysts have been thus cured, sudden death, secondary infiltration of the peritoneal cavity with the hydatids, peritonitis, and other accidents have followed this treatment. When the cyst has suppurated, it should be opened, washed out and drained.

III. *Cysts of congenital origin.*

Congenital cysts may be formed in various ways:—1. By the inclusion of a portion of epiblast within the mesoblast (*dermoid cysts*). 2. By the distension in after life of some fœtal structure which has not become obliterated in the course of normal development; for example, encysted hydrocele of the spermatic cord developed in an unobliterated portion of the funicular process of the tunica vaginalis, cysts in the middle line of the neck arising in remains of the thyroglossal duct, and certain broad ligament cysts developed from the parovarium. (See *Testicle, &c.*) 3. By the inclusion of a blighted ovum in a part of the embryo. Such at least is the origin ascribed to certain cysts containing pieces of bone, cartilage, teeth, &c., occasionally found in connection with the ovary and testicle.

Another form of congenital cyst, known as the *cystic hygroma*, is not uncommon. It consists of dilated lymphatic spaces with a varying amount of fibrous, fatty and nævoid tissue around, being almost solid or quite cystic according to the proportion of the solid elements. Hygromata occur in the neck, axilla, scrotum, &c. Their origin has not at present been satisfactorily explained.

Of the congenital cysts, the *Dermoid* only are described here.

Dermoid cysts are cysts in the walls of which are found all the structures constituting the true skin and its appendages, such as hair, hair-follicles, sebaceous glands, &c. The contents, which resemble sebaceous matter, consist of the secretion of the glands in the cyst-wall, and of epithelial débris, and frequently of hair. They are often quite unconnected with the skin, and their origin is attributed to the inclusion of a portion of the epiblast in the mesoblast, an explanation which in the region of the neck and face is probably correct, as these cysts are usually formed about the outer angle of the orbit, and in other of the situations at which in the embryo a cleft or fissure exists between the processes from which the face or neck are developed. In some dermoid cysts of the ovary, teeth also are occasionally found. The origin of these, as of the dermoid cysts of the testicle, are not so obvious. *Signs.*—The dermoid cyst so common near the outer angle of the orbit forms a smooth, tense, globular tumour, generally freely moveable on the parts beneath. It is always congenital, grows slowly, and though generally small may attain a considerable size. *Treatment.*—The cyst should be dissected out by an incision through and parallel to the eye-brow, in order that the scar may be as much as possible hidden. At times these cysts send processes beneath the eye-lid, or into the orbit, and they have even been known to perforate the bone and extend into the interior of the skull. Care, therefore, is necessary in their removal.

SECTION II.

General Pathology of Injuries.

WOUNDS.

Wounds are divided into two great classes, the *open* and the *subcutaneous.*

Open wounds.—A wound has been defined as 'a solution of continuity in any part of the body, suddenly made by anything that cuts or tears, with division of the skin.' Here our attention will be confined to the general pathology and treatment of wounds of the soft tissues. Wounds of special tissues, as bone, muscle, blood-vessels, nerves, &c., will be further referred to under those heads.

The process of repair in open wounds of the soft tissues differs according as the wound is incised, lacerated, contused, or punctured, and according as it is, or is not, kept aseptic, properly drained, and protected from infective processes. The healing process will, moreover, be influenced by the patient's state of health previous to the wound, and the hygienic conditions under which he is subsequently placed. Let us first take a *general view of the process of repair* as it occurs in a simple incised wound in a healthy subject. Immediately the wound is inflicted there will be free hæmorrhage varying in amount according to the vascularity of the part, probably a spouting of blood in jets from a few larger arteries, and a more or less general oozing from the smaller vessels and capillaries. The hæmorrhage from the larger arteries having been arrested, and that from the smaller having ceased spontaneously, the wound, if accurately closed and kept aseptic and at rest with its surfaces in contact, will unite without suppuration by a process of *simple or adhesive inflammation.* Thus, the edges of the wound for the first day or two may present a very faint blush of redness extending for a few lines to perhaps in a large wound half an inch or so beyond the incision; whilst they may be slightly swelled, a little hotter than natural, and tender on pressure, but quite devoid of pain. The redness, swelling and heat, however, may be so slight as to be almost imperceptible, or indeed may be said in some instances not to occur. If an attempt were now made to draw the edges apart, they would be found adherent to each other, and a few days later firmly united. All trace of redness and swelling about the edges will by this time have disappeared, a red streak only remaining to mark the line of the wound. This streak grows paler and paler, till ultimately a thin white line, which in course of time may become hardly perceptible, alone indicates the site of the injury. The above-mentioned process, which should be attended by little or no constitutional disturbance, is known as healing by the *first intention*, and is the one which, other things being equal, is always aimed at by the surgeon in the treatment of wounds. If the wound does not admit of its surfaces being placed wholly in contact, the space left becomes filled with blood, and the wound, if kept perfectly aseptic, unites in a way similar to that above described, without suppuration. This method of healing, which is practically one by the first intention, is known as *healing by blood-clot*. It is the way in which subcutaneous wounds usually unite. Should, however, the wound, whether its surfaces be in contact or be separated by blood, be not kept aseptic, the inflammatory redness and swelling of the edges, instead of subsiding and disappearing in a few days, will increase and extend for some distance around ; the parts then become tense, there may be throbbing pain, union fails, and suppuration is set up. In the meantime the patient may have a chill or even a distinct rigor ; the temperature rises ; the pulse is increased in frequency ; the tongue becomes coated, the skin hot and dry, the urine scanty and high coloured, and the bowels confined ; he complains of headache and loss of appetite, and there may be restlessness and want of sleep and perhaps slight delirium (*septic traumatic fever*). If now a free exit is established for the pus, or broken-down blood and pus, and further septic changes are prevented, the constitutional disturbance subsides, and the surface of the wound becomes covered with granulations. The granulations gradually fill up the wound, and when the level of the skin or mucous membrane is reached, epithelium slowly spreads from the edges of the wound over the granulations till they are completely covered in. A red scar is thus left at the seat of the former wound, and though this in the process of time assumes a white colour, and becomes smaller from the contraction of the fibrous tissue into which the granulations are at length converted, it is of a permanent character. The above method of repair is known as healing by the *second intention*, or by *granulation*.

In wounds where there is loss of substance so that the edges of the skin cannot be brought into contact, the cavity becomes filled with blood-clot, and, if the wound be kept aseptic, repair occurs without suppuration, the blood-clot, though passive, forming a nidus in which the process of union takes place. Or, if no blood-clot is present, the surface, after the hæmorrhage has been stopped, becomes glazed over, and a reddish serum slowly escapes ; granulations appear, first here and there, and finally over the whole surface of the wound, which is then gradually filled up as described above. In lacerated wounds the same process occurs, the dead portions of the lacerated tissues, however, being first thrown off in the form of sloughs. In flap wounds where adhesion by the first intention has failed, after the surfaces of the flaps have become covered by granulations the two layers of granulations in contact may unite, a mode of healing known as *secondary adhesion* or union by the *third intention*. Yet again, when a wound has been sealed by blood or discharges, it may unite either by adhesive inflammation or by granulation, the process being hidden by the scab of hardened blood and discharges, on the separation of which the wound is found soundly healed. It is the common method of healing among animals, and is known as *healing under a scab*, or as it was humorously described by Sir James Paget in his lectures on Surgery, as union by no intention at all.

Thus a wound may heal, 1, by the first intention (a) by adhesive inflammation; (b) by blood-clot; 2, by the second intention, or by granulation; 3, by the third intention, by secondary adhesion or by union of granulations; and 4, under a scab. These methods of healing may now be studied more in detail.

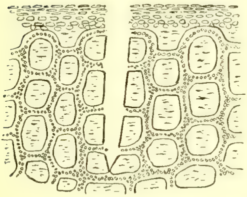

FIG. 23.—Diagram representing a simple incised wound, immediately after the incision has been made.

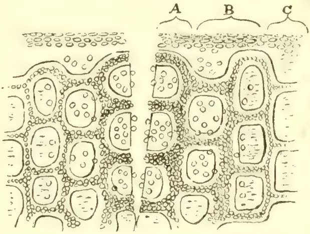

FIG. 24.—Diagram representing an incised wound a few hours after the incision. A. Area of thrombosis — leucocytes making their way to the cut surface. B. Area of dilated capillaries—leucocytes escaping from the vessels into the tissues. C. Normal tissues.

1. *Healing by the first intention.* (a) *By adhesive inflammation.*—Chiefly as the result of the injury inflicted on the tissues by the instrument making the wound, and to a less extent as the result of exposure to the cold air and it may be of the irritation of strong chemical antiseptics, a simple traumatic inflammation is set up in the layer of tissue bounding the incision (Fig. 23 and Fig. 24). As a consequence, stasis and coagulation of the blood is induced in the divided smaller vessels and capillaries, and thus

the hæmorrhage from them spontaneously ceases (Fig. 24). Immediately around there is dilatation of the vessels with retarded flow, proliferation of the connective-tissue cells, and escape of leucocytes and liquor sanguinis. These infiltrate the tissues adjacent to the incision, and pass through the cut lymph-spaces on to the raw surface of the wound. There coagulation occurs, the fibrin and the entangled corpuscles forming a layer of coagulable lymph between the surfaces of the wound, whilst the serum, at first red from the presence of red corpuscles but subsequently becoming colourless, drains gradually away. It is this coagulable lymph which causes the surfaces of the wound after the first few hours to adhere, or to become glazed if the wound is kept open for some time before the edges are approximated, as was formerly a not uncommon practice. A little further from the line of incision there is the usual inflammatory phenomenon of dilated vessels with accelerated flow (Fig. 24), thus accounting for the faint blush of redness and the slight swelling about the edges of the wound. The coagulable lymph uniting the surfaces of the wound, together with the tissues immediately adjacent to the incision, next become softened and finally replaced by the infiltrating lymphocytes and proliferating connective-tissue and endothelial cells, which now form a layer of small round cells welding as it were the surfaces of the wound together (Fig. 25). The inflammation, like all inflammations of traumatic origin, tends to cease as soon as the cause is removed. Thus in a day or two it subsides, and if a section of the parts were now made, the uniting layer of small round cells would be seen permeated by delicate new capillaries stretching across from one side of the

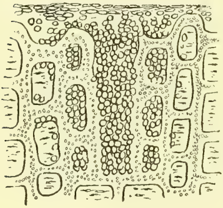

FIG. 25.—Diagram of an incised wound a day or two after the incision. The sides of the wound united by small round cells.

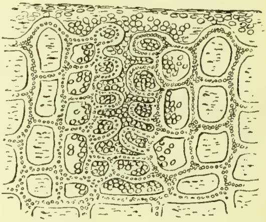

FIG. 26.—Diagram of an incised wound a few days after the incision. Loops of capillaries growing out from the old capillaries and making their way amongst the small round cells uniting the cut surfaces. At the lower part of the figure a loop has united with one from the opposite side.

wound to the other (Fig. 26). They are generally believed to be produced by loops growing out from the old capillaries, and uniting with others similarly produced and growing out from the capillaries on the opposite side. This vascularization of the uniting layer of cells accounts for the redness of the cicatricial line, and for the slight hæmorrhage which now occurs if the edges of the wound be drawn forcibly apart. As the capillary circulation is established, the edges of the wound become pale from the collateral vessels being now no longer over-charged. The granulation-tissue thus formed is at length developed into fibrous tissue, which, like all new fibrous tissue, contracts, obliterating many of the newly-formed vessels. Hence the gradual paling of the cicatrix, which now becomes practically non-vascular.

(b) *By blood-clot.*—When the surfaces of the wound cannot be brought together, as is frequently the case in deep wounds, the cavity left becomes filled with blood. The blood clots, and, if the wound is kept aseptic, healing proceeds in a similar manner as described above. The clot remains passive, the surfaces of the wound between which the blood-clot lies become sealed by lymph, leucocytes and lymphocytes invade the clot and destroy the red corpuscles, large cells derived from the endothelium and connective-tissue cells follow, dispose of the leucocytes, and then develop into connective tissue. Subsequently vascularization and afterwards contraction take place as in wounds in which the surfaces are in contact.

Healing by the first intention may be prevented by—1. Much contusion of the edges of the wound, with consequent death of the tissues bounding the incision; 2. The presence of a septic foreign body in the wound; 3. A greatly lowered vitality of the tissues, as from broken health, abuse of alcohol, diabetes, bad hygienic surroundings, bruising of the parts, rough sponging, or use of too strong antiseptics; 4. The parts not being kept at rest with the surfaces of the wound in accurate apposition; 5. Inefficient drainage whereby the serum squeezed out from the coagulating material is allowed to collect in the wound and cause tension; 6. Neglect of antiseptic precautions and consequent decomposition of the serum or the infection of the wound by some of the specific micro-organisms introduced either at the time it was inflicted or subsequently. Under any of the above circumstances the inflammation may be kept up, the pyogenic micrococci may gain a footing, and further infiltration of leucocytes and proliferation of tissue-elements take place; the small-cell-exudation uniting the wound then breaks down into pus, the flaps separate, and suppuration is established. Supposing the cause of the inflammation to be now removed, healing by the second intention will ensue.

2. *Healing by the second intention.*—New vessels grow out among the layers of small round cells forming the exposed surface of the

wound, and granulation-tissue is thus formed (Fig. 27). The growth of granulations, other things being equal, exceeds the breaking down of the superficial layers of cells, and the wound is gradually filled up. Epithelium derived from the old epithelium at the edges of the wound gradually spreads over the surface of the granulations; but new sweat and sebaceous glands, hair follicles, papillæ and lymphatics, are not formed. The cicatrix, at first red from the abundance of the capillaries in the granulation-tissue, becomes pale as these are obliterated by the contraction of the fibrous tissue into which the granulation-tissue is converted, and though, in the course of time, in consequence of the fibrous contraction, it becomes smaller, a permanent scar will remain.

In wounds attended with loss of substance, a traumatic inflammation is set up in the tissues immediately adjacent to the surface of the wound, and the conditions for healing being otherwise favourable, a coagulable material, as described above, is formed over the surface, and the serum drains away. Loops of new capillaries, derived from the old, spring up amongst the cells replacing the coagulable exudation and softened adjacent tissues, and the wound heals and cicatrizes as has just been described. If the wound is filled with blood the clot undergoes the same changes described under healing by blood-clot, the surface of the clot, however, forming a protective layer whilst the invasion of the rest of the clot is going on. Finally, epithelial cells grow out from the edges of the wound below the protective layer of clot, so that when this falls off or is removed the surface is found restored. Where there is much laceration or contusion of the surface of the wound, the dead tissues are first cast off by ulceration in the way mentioned under gangrene.

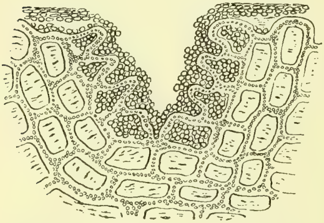

Fig. 27.—Diagram of granulating wound.

3. *Healing by the third intention.*—When the two layers of granulations covering the flaps of the wound are placed and kept in contact, the capillaries in the one layer meet with those in the other, and so establish a vascular connection between the two flaps, and the healing of the wound then proceeds in the way described under union by the first intention.

4. *Healing under a scab.*—The minute changes of healing under a scab require no special description.

Treatment of wounds.—The general principles which should guide us in the treatment of wounds will be considered under the following heads :—1, Arrest of hæmorrhage; 2, Cleansing of the wound and removal of foreign bodies; 3, Drainage; 4, Closing the wound and keeping it subsequently at absolute rest; 5, Prevention of putrefaction, fermentation, and infective processes; and 6, Constitutional treatment.

1. *The arrest of hæmorrhage* is considered separately at p. 111.

2. *The cleansing of the wound and removal of foreign bodies* should be done with all gentleness, so as not to bruise the tissues more than can possibly be avoided, their vitality being already lowered by the incision through them. Thus the wound should not be sponged or rubbed more than is absolutely necessary, but a stream of water previously boiled, or if preferred containing some efficient antiseptic, as corrosive sublimate (1 in 500), allowed to run through it to wash away any blood-clot, or in the case of accidental wounds any dirt or other foreign substance that may have gained admission. If the wound is deep or irregular, it should be irrigated, care being taken when the skin-wound is small not to cause any forcible distension for fear of driving the fluid into the interstices of the tissues, where it may act as an irritant and set up inflammation. Foreign bodies, as glass, splinters, bullets, &c., if lodged in the wound, should be picked out by forceps or other suitable instrument.

3. *Drainage.*—Where a wound is quite superficial, and in some situations where the parts are very vascular, as about the face, and for moderate-sized wounds in which the surfaces can be kept in contact by pressure, drainage is not necessary. Such wounds may be completely closed if clean cut and moderately small; or a stitch may be omitted at one end; or a loop of pewter wire inserted, but only deep enough to keep the edges of the skin apart at that place. If, however, the wound is large or irregular or lacerated, and the surfaces cannot be kept in contact, or it is doubtful if it has been made aseptic, efficient drainage of the wound is of the greatest importance. Its object is to promote the free escape of the serum, which, as we have seen, is squeezed out during the first twenty-four hours from the coagulable exudation formed upon the surface of the divided tissues as the result of the traumatic inflammation. If this serum is allowed to collect in the deeper parts and irregularities of the wound, it not only mechanically separates the surfaces and gives rise to tension, a cause in itself of the continuance of inflammation and hence of the non-healing of the wound, but is also liable to undergo decomposition and putrefaction, and form a suitable nidus for the growth of pyogenic micro-organisms. Now the coagulable cellular exudation, being living tissue, resists the agents which determine putrefaction. Not so the serum. In this we have a fluid containing dead animal matter, and as the other conditions favourable for decomposition are also present, viz., a temperature of about 100°, and a sufficient supply of water and oxygen, the

addition of a ferment only is required to set it up. If decomposition or fermentation then is suffered to take place through not keeping the wound aseptic, or the pyogenic micrococci are allowed to enter, the freshly-divided tissues, not as yet sealed by traumatic inflammation, permit the products of decomposition or of the micrococci to soak into the tissues around, setting up locally a septic or spreading inflammation, whereby the coagulable cellular exudation, temporarily holding the surfaces of the wound in apposition, is destroyed, and healing by the first intention is prevented. In the meantime the products of decomposition may pass into the blood, and give rise to the constitutional state known as septic traumatic fever, or if the dose of the poison is large, to sapræmia or septic intoxication; and this is the more likely to occur if the wound has been closed, so that the decomposing serum is pent up under some degree of tension. If therefore the wound is very large and deep, or lacerated or irregular, and we are doubtful as to its being aseptic, a drainage tube or tubes should be placed in it, and brought out at the most dependent part, the incisions, if the wound is made in an operation, being so planned as to allow as much as possible of a dependent drain. For smaller wounds it may be sufficient to place in them a leash of horse-hair or of catgut, a piece of gutta-percha tissue, or a strand or two of pewter wire. The drain-tube if kept in too long will act as a foreign body, set up inflammation, and give rise to a suppurating sinus along its track. It should therefore be withdrawn as soon as the serum ceases to be squeezed out from the coagulating material—*i.e.*, in from twenty-four to forty-eight hours, according to the size of the wound. The drain-tube should consist of red-rubber tubing, varying in calibre according to the size of the wound. It should have lateral holes cut in it to facilitate the escape of the discharge, and should be made thoroughly aseptic by being sterilized or boiled, and then kept in some antiseptic fluid. It had better be passed through the first layer of dressing, and its mouth surrounded by some absorbent material to take up the discharges. Where the wound is deep, the tube should be secured by a safety-pin or by an aseptic thread, lest it slip in, and, becoming lost in the depth of the wound, subsequently act as a foreign body. Tubes of decalcified bone have been used in the hope that they would become absorbed, and so prevent the necessity of disturbing the dressings; but they do not appear to have had the desired effect. Many surgeons now seldom or never use drain tubes. I only use them myself under the conditions stated above. Where they are dispensed with the skin wound is then not as a rule tightly closed, and the deeper parts of the wound are maintained in close apposition by means of buried or deep sutures and the application of firm pressure over a thick layer of absorbent and antiseptic dressing.

4. *Closure of the wound.*—The surfaces should be placed in contact, and the edges accurately united by suture, strapping, or a bandage. Where the wound involves different layers of tissue, muscle and fascia should be united, each to each, by aseptic sutures. In uniting the edges of the wound, care should be taken to see that the skin is neither inverted nor everted, and that the sutures, whatever form is used, are only tied sufficiently tight to keep the edges in apposition. All tension should be avoided, as this in itself is a fertile cause of inflammation. The sutures may consist of silk, silk-worm gut, horse-hair, catgut, or silver-wire. All kinds have their advantages and disadvantages, and are variously required in different cases. Thus, silver-wire is unirritating and perfectly non-absorbent, but causes pain on removal, and, as it is quite unyielding, is apt, from the swelling of the parts, to cause tension and inflammation if left in too long. Catgut is useful in that its deeper parts become absorbed, and therefore does not require removal. For this reason it is often inapplicable, as it gives way too soon. Catgut when chromicized resists absorption for many days, and forms an admirable suture. It is difficult, however, to ensure it being aseptic, and it is therefore abandoned completely by many surgeons. Horse-hair is non-absorbent, and is also non-absorbable; it has the additional advantage of being slightly yielding as well as sufficiently supporting. It is very useful when a delicate suture is required, as in wounds about the face. Silk forms a strong suture, but possesses the disadvantage of being absorbent and thus of becoming saturated with the discharges, so that, if decomposition takes place, it will act as an irritant. Further, unless tied tightly, in which case it is apt to produce tension, it yields too much. At the present day, however, fine silk, horse-hair, and silk-worm gut are, on the whole, the favourite sutures. Sutures may be made aseptic by boiling or by soaking for twenty-four hours in 1 in 500 perchloride of mercury solution. They should then be kept in absolute alcohol 3 parts and perchloride of mercury solution (1 in 200) 2 parts, or they may safely be kept in carbolic lotion (1 in 20).

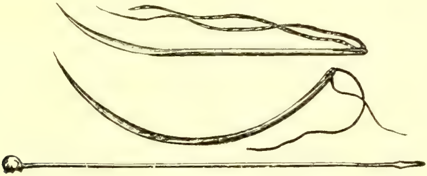

FIG. 28.—Surgical needles and hare-lip pin.

The sutures are introduced by various forms of surgical needles, curved and straight, bayonet- spear- and probe-pointed (Fig. 28), the needle being conveniently passed by one of the many forms of needle-holder (Fig. 29). The methods of applying sutures are very numerous. The two chief forms of sutures used in ordinary wounds are the *interrupted*, the suture being tied or twisted at each stitch and cut off short, and the *continuous*, one suture being used throughout without being cut. Among the special forms may be mentioned the twisted, the button, the quilled, the Lembert, the Jobert, the Halsted, and the Czerny, which are referred to under those wounds where they are specially indicated. The other methods of closing wounds, as by styptic colloid, iodoformized collodion, and collodion, are useful in wounds about the face, and where the wound is small. Having closed the wound, the parts should be placed as far as is possible at absolute rest, and supported by firm but elastic pressure to ensure the deeper surfaces being in apposition.

5. *Prevention of putrefaction, fermentation, and infective processes occurring in the wound.*—Putrefaction and fermentation are best prevented by thorough asepsis, or by efficiently draining the wound, or by keeping the surfaces in contact by firm pressure, as there is then no material present in the wound wherein decomposition can occur. Antiseptics, viz., agents that destroy septic and infective organisms, are adopted by many surgeons as an extra precaution, and are especially necessary where thorough asepsis cannot be insured, or drainage or efficient pressure, as in some forms of compound fracture, wounds of joints, &c., cannot be employed. It is questioned by some pathologists, however, if our so-called antiseptics are efficient destroyers of micro-organisms or their spores, unless used so strong that they endanger the vitality of the tissues; some surgeons trust therefore merely to asepsis, *i.e.*, absolute cleanliness, and have abandoned all antiseptics.

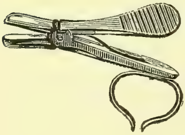

FIG. 29.—Convenient needle-holder.

But we have to guard, not only against the decomposition of the discharges, but also against the entrance of infective micro-organisms, conveyed by instruments, sponges, the surgeon's or nurse's hands, or by the air when an infectious case is in the ward. The greatest cleanliness therefore is necessary. All instruments should be carefully cleansed after use before they are put away, and before being used again they should be sterilized by boiling them in water to which 1 to 3 per cent. of bicarbonate of soda or caustic soda has been added, or by passing them through the flame of a spirit lamp, or laying them in the steam sterilizer. Whilst in use they should be placed in carbolic acid lotion (1 in 20). Sponges, except new ones, had better not be used at all, but dabs of sterilized cotton-wool, which can be destroyed immediately after the operation. New sponges after cleansing should be kept in carbolic acid (1 in 20). The sponges should be passed to the surgeon in a sterilized bowl after being washed and placed in corrosive sublimate solution (1 in 1,000). The hands of the surgeon, assistants, and nurse should be scrupulously cleaned by thoroughly washing in soap-and-water, the nails, previously well pared down, being cleansed with an aseptic nail-brush. They should be then further purified by dipping them into a solution of biniodide of mercury, rectified spirits, and iodide of potassium for a few minutes, and then rinsed in carbolic acid (1 in 20), or corrosive sublimate (1 in 1,000). Previous to the operation the part should be shaved, if necessary, and washed with soap-and-water for some distance around where the wound is to be made, and afterwards with carbolic acid (1 in 20), or corrosive sublimate (1 in 1,000), and where greasy, with turpentine or ether. An antiseptic dressing should then be applied and kept on till the patient is on the operating table. Before the dressing is removed, sterilized towels wrung out in warm carbolic lotion (1 in 20) should be arranged around the part where the wound is to be made so as to prevent the clothes coming into contact with the wound, the wetting of the patient's clothes being prevented by placing aseptic mackintosh cloths beneath the carbolized towels. In place of carbolized towels, dry towels fresh from the sterilizer are preferred by some surgeons. On the removal of the dressing the parts should be again sponged with the antiseptic—carbolic lotion (1 in 20) or corrosive sublimate solution (1 in 500). The wound should be irrigated from time to time with corrosive sublimate (1 in 2,000), carbolic acid (1 in 40), or with boiled water, and the surgeon's hands cleansed from blood by dipping them in boiled water or antiseptic solutions. At the end of the operation the wound should be finally irrigated before being closed.

In a work of this character it would be impossible to attempt any description of the numerous methods of dressing wounds which have been, or are at the present day, in use, and to adequately discuss the advantages claimed for them, and the disadvantages which all of them to a greater or less degree possess. The objects aimed at in the selection of a dressing are—1, that it should be absorbent, so as readily to soak up the discharges drained off from the wound; 2, that it should promote the drying of the wound; 3, that it should be antiseptic or aseptic; and hence, 4, that it should not require frequent changing, since such necessarily disturbs the wound and therefore deprives the tissues of that rest which is so important in promoting physiological repair. The materials most frequently used are gauze or cotton-wool, impregnated with sal alembroth or the double cyanide of mercury and zinc, or simply sterilized by dry heat or superheated steam. My own plan is to dress the wound with several layers of moist sal alembroth gauze, over which is placed dry gauze and a thick layer of dry sal alembroth wool. Where the skin is very irritable a layer or two of iodoform gauze is placed next to it beneath the other dressing. Firm compression with a bandage is then applied. The wound is now left absolutely at rest till healing is thought to have taken place. The temperature and pulse are, of course, carefully watched; and should they indicate any abnormality in the process of healing, or should there be local pain or uneasiness, the wound is looked at and the dressings re-applied.

6. *Constitutional treatment.*—Whether the wound is received accidentally, or is inflicted in the form of an operation, much of the surgeon's success will depend upon judicious constitutional after-treatment; and, indeed, in the latter case, in great measure also upon the preparation of the patient. Where the wound is large and there has been much hæmorrhage, the condition known as shock, and the constitutional symptoms depending upon severe loss of blood, will probably ensue (see *Shock* and *Hæmorrhage*). For the wound to do well it is important that the patient should be placed under the best possible hygienic conditions. He should have an abundant supply of fresh air, the secretions should be regulated, and the diet carefully supervised. Thus, he should have at least fifteen hundred cubic feet of air, and this should be changed by efficient ventilation at least three times every hour. The windows, in addition, except in very severe weather, should be opened at regular intervals, in order to thoroughly flush out the room; but draughts must be avoided, and the temperature of the room maintained at a uniform degree of about 60° F. A horsehair mattress should be employed, and a draw-sheet placed on the bed. The room or ward should be scrupulously clean; there should be no curtains to the bed and windows, or planned carpet on the floor, and nothing under the bed to interfere with the free circulation of air. The bowels should be kept regular by small doses of confection of senna or of the compound liquorice powder, or by one of the laxative mineral waters; the secretion of the skin promoted by washing, which may be done without unduly exposing or wetting the patient; and sleep induced, if necessary, by bromide of potassium, bromide of ammonium, paraldehyde, urethane, chloral, sulphonal, or opium, or by subcutaneous injections of morphia. The patient must be kept cheerful by books, newspapers, &c. The diet for the first few days should be limited to milk, weak beef-tea, or chicken broth, and gradually increased if the temperature remains normal and as the digestive functions regain their power. Where the strength has been much reduced previous to the operation, or the operation has been severe, or the shock marked, or hæmorrhage free, or suppuration has ensued, stimulants, varying in amount

according to the state of the pulse, temperature, and tongue are indicated. The treatment necessary for the various complications that may attend the healing of wounds are given under Inflammation, Suppuration, Erysipelas, &c. As regards the *preparation for operation*, where this is not one of emergency the patient should be placed at rest for a few days, and kept cheerful and in good spirits, and put on nourishing but unstimulating diet. In the meantime his digestive, alvine, renal, and cutaneous functions must be regulated by appropriate means, the bowels being cleared the day before the operation by a dose of castor-oil or other mild purgative. Where his strength is much reduced by long-continued suppuration or chronic disease, efforts must be made to improve his general health by nourishing diet and the judicious employment of stimulants.

VARIETIES OF OPEN WOUNDS.—Open wounds are divided into incised, lacerated, contused, punctured, and poisoned.

Incised wounds are such as have their edges evenly divided and their surfaces smoothly cut. They are usually inflicted by sharp instruments, and are those commonly made by the surgeon in operating. The danger which is particularly liable to attend them is hæmorrhage. Healing is generally accomplished by the first intention, provided the proper means are employed. *Treatment.*—What has been said under the treatment of wounds generally, applies especially to this variety.

Lacerated wounds are those in which the tissues forming the surface and edges of the wound are irregularly torn. They are commonly caused by machinery, and by the goring and bites of animals. There is usually but little hæmorrhage, in consequence of the vessels being torn rather than cut across. The chief dangers are profuse suppuration, tetanus, sapræmia, erysipelas, and extensive scarring. Healing is generally accomplished by the second intention, the dead portions of the lacerated tissues being first thrown off by ulceration in the way described under Gangrene. In some situations and under favourable conditions, however, a large part of the wound may heal by the first intention. *Treatment.*—Special attention should be paid to the cleansing of the wound and establishing a free drain. Any portions of the tissues which have obviously lost their vitality should be cut away. Sutures should not as a rule be applied, but the wound should be dressed by one of the methods before described, and the parts placed at rest.

Contused wounds are those in which the tissues forming the surface and edges are extensively bruised. They are usually made with blunt instruments or with such agents as distribute the force over a large surface. There is commonly considerable extravasation of blood amongst the bruised tissues, though usually but little external hæmorrhage. The chief dangers are extensive inflammation and sloughing, secondary hæmorrhage on the separation of the sloughs, spreading gangrene, erysipelas or diffuse cellulitis, tetanus, and, later, scarring. A combination of laceration and contusion is frequently present. Healing is generally accomplished by the second intention. The *treatment* is similar to that of lacerated wounds. Any portions of skin which have not lost their vitality should be preserved, especially if the wound involves the scalp or face.

Punctured wounds are those in which the depth is much greater than the breadth. They are usually produced by sharp-pointed instruments, bayonet or sword-thrusts, and stabs. The chief dangers are hæmorrhage, penetration of important cavities, as the thorax, abdomen, or a joint, injury of a large blood-vessel or nerve, and subsequently deep suppuration in consequence of the retention of the discharges in the deep portion of the wound. Punctured wounds usually unite by the second intention, owing to the difficulty of keeping the deeper parts of the wound in contact and of preventing the collecting of serum and later of pus. *Treatment.*—If deep, a drainage-tube should be passed to the bottom of the wound, and gradually shortened as the wound heals. If there is severe arterial hæmorrhage which cannot be controlled by carefully applied pressure, the wound must be converted into an incised one, and the bleeding vessel treated in the way described under Wounds of Arteries, Veins, &c. For the special treatment required where a joint or visceral cavity has been penetrated, see *Injuries of Regions.*

POISONED WOUNDS. *Dissection and post-mortem wounds.*—Dissection wounds are of frequent occurrence, but seldom give rise to any serious trouble, unless the body from which the poison is received is fresh, when the risks are similar to those attending wounds received in making *post-mortem* examinations. *Post-mortem* wounds owe their virulence to inoculation with infective micro-organisms which are capable of multiplying in the tissues or even in the blood, and so setting up true infective inflammation and blood-poisoning. These micro-organisms are crowded out or replaced, as decomposition of the corpse sets in, by the bacteria of putrefaction. Hence the longer the body has been kept, the less dangerous the wound, as these bacteria are merely capable of inducing a local inflammation, and not a true infective process. The most dangerous wounds are those received whilst examining bodies in which death has recently resulted from septicæmia, pyæmia, diffuse or puerperal peritonitis, and erysipelas. The effects of a wound received in dissection, or in *post-mortem* inspection, will depend in some degree upon the health of the operator; if strong and vigorous he is better able to resist the toxic effects than when debilitated by prolonged study or work in a hospital ward. On the other hand, persons acclimatized to the dissecting or *post-mortem* room are less liable to be affected than those who have but recently been engaged there.

The *signs*, as might be expected from what has been said above, vary considerably, depending, as they do, upon the nature of the poison received from the corpse and the previous state of the operator's health. Thus: 1. A pustule may form at the seat of inoculation, and, after breaking and scabbing, leave a raised, indolent, painful red sore, which may exist for months, in spite of treatment. 2. The scratch or wound may become inflamed, the superficial and perhaps the deep lymphatics implicated, and the axillary glands enlarged and painful, this condition being attended by sharp constitutional disturbance, often preceded by a rigor. Suppuration generally occurs at the seat of inoculation, and sometimes also in the axillary glands. The prognosis is usually good. 3. With or without the local signs of the preceding form, severe constitutional symptoms may set in, preceded by a rigor, and rapidly assume a typhoid character. Diffuse suppuration occurs in the axillary glands, and may spread to the neck and side of the chest. The prognosis is very unfavourable, the patient often dying in from one to three weeks, or only recovering after a tedious convalescence, and then, probably, with a broken constitution. 4. Diffuse cellular, or cellulo-cutaneous erysipelas may be set up at the seat of inoculation, attended with the usual constitutional symptoms of these affections, and may rapidly spread up the limb and terminate in gangrene and death. The axillary glands in this form are not usually affected. 5. In addition to the local suppuration, a pyæmic state, with the formation of metastatic abscesses in various tissues and organs, sometimes occurs.

Treatment.—Immediately on its infliction the wound should be sucked, and cleansed by a stream of cold water, and bleeding encouraged and absorption prevented by tightly binding the part above the wound. Where the corpse is recent and death is known to be the result of some infective disease, the wound should be washed in strong carbolic or corrosive sublimate lotion (some recommend its cauterization with caustic potash, or nitrate of silver), and then dressed and protected from further infection. If a wart or indolent sore form, it should be destroyed by nitrate of silver, acid nitrate of mercury, or other caustic, and the patient's health improved by tonics and change of air. If an infective inflammation be set up, the wound should be freely incised, and any abscess that may form in the axilla, or elsewhere, opened early; indeed, if there is much tension or brawniness of the parts, incisions should be made before pus has formed. The bowels in the meantime should be cleared by a brisk purge, and the strength supported by nourishment and stimulants.

Stings of insects sometimes cause troublesome local inflammation, which is occasionally of a diffuse character, and where a large extent of surface is stung, as by a swarm of bees, may be attended with symptoms of severe depression. Stings of the throat occasionally occur from swallowing a wasp, and are liable to be followed by œdematous laryngitis. *Treatment.*—The application of ammonia will at once relieve pain. Where there is severe depression, ammonia or alcohol must be administered. Scarification, intubation of the glottis, or even laryngotomy, may become necessary in severe stings of the throat.

Snake-bites.—The bites of poisonous snakes, other than the adder, are fortunately rare in this country. The bite of the common adder is seldom fatal. It is attended with much collapse, nausea or vomiting, great pain in the part, swelling of the affected member, subsequent discoloration from blood extravasation, and occasionally inflammation and suppuration. The *treatment* consists in sucking the part where practicable, applying a bandage tightly above the bite to prevent absorption of the poison, and the internal administration of stimulants. The local application of hypochlorite of calcium solution (1 in 60) or of liquor potassæ or permanganate of potash, the injection of ammonia into the veins, and excision of the bitten part are recommended. Recently an antitoxic serum has been prepared from immunized animals by Calmette and Fraser which, if at hand, should certainly be used. For an account of the more serious symptoms attending the bite of the cobra and other venomous serpents of tropical countries, a larger work must be consulted.

SUBCUTANEOUS WOUNDS.—A wound, whether it be of the connective tissue, bone, muscle, tendon, or other structure, is said to be subcutaneous when the skin or mucous membrane remains intact. Such wounds differ from the open in that they heal by adhesive inflammation without suppuration, since as long as the skin or mucous membrane covering the wounded part is unbroken, septic processes are effectually prevented. Moreover, they are attended by but little, if any, constitutional disturbance. They will be further described under *Rupture of muscles and tendons*, *Simple Fractures*, *&c.*

DISEASES OF CICATRICES.—The cicatrices left on the healing of a wound are liable to certain affections which may be enumerated as:—1, painful cicatrix; 2, depressed or contracted cicatrix; 3, warty cicatrix; 4, thin cicatrices; 5, ulceration; 6, keloid; and 7, epithelioma, and more rarely sarcoma. See *Ulceration*, *Tumours*, *&c.*

CONTUSIONS OR BRUISES.

Contusions are subcutaneous injuries, occasioned by a crushing, pulping or tearing of the tissues, combined with extravasation of blood consequent upon the rupture of the capillaries and smaller vessels of the part. In their slighter forms they constitute the common injury known as a *bruise*. The effused blood generally makes its way in the connective-tissue planes towards the skin, giving rise to the characteristic purplish-black appearance, and, as it later breaks down and becomes absorbed, to a change of colours from bluish-black through dark red to yellowish-green. In severe cases the cuticle is raised into bullæ by the effusion of blood-stained serum beneath it. These bullæ, together with the black colour of the part, may occasion a close resemblance to gangrene, from which, however, a contusion may be distinguished by there being no loss of heat or of sensation in the part, and by the bullæ being fixed, and not changing their position on pressure as in gangrene. In very severe and extensive contusions, however, the tissues may be so injured as to lose their vitality, and gangrene actually ensue; whilst in other instances inflammation and suppuration may occur. When the contusion is localized, blood to a considerable amount may be poured out at the injured spot, forming a fluctuating swelling known as a *hæmatoma*. Contusions of muscle, bone, blood-vessels, and nerves, and contusions of the viscera, are considered separately under Injuries of Special Tissues and Organs.

Treatment.—Beyond placing the part at rest, and applying an evaporating or a spirit lotion, nothing more as a rule is required, as the extravasated blood presses upon the injured vessels, and so prevents further hæmorrhage. Should a hæmatoma form, it should on no account be opened, as the blood will usually become absorbed; whilst, if air be admitted, suppuration will probably ensue. Aspiration, however, when the hæmatoma is very large, may occasionally be done with advantage.

BURNS AND SCALDS.

Burns and scalds vary in their effect according to their depth, extent, situation, and the age of the patient. An extensive though superficial burn on the trunk, head or face, especially in a child, may be more serious than a deeper but limited burn on the extremities. A burn is usually said to be more severe than a scald, as the fluid producing the latter generally quickly cools and runs off. A scald, however, owes its severity to the large extent of surface usually implicated, and when produced by molten metal or boiling oil which adheres to the part, is generally very serious. Burns and scalds, when severe, give rise to constitutional as well as local effects. The local effects may be considered under Dupuytren's division of burns into six degrees. These degrees, however, may be variously combined in the same burn.

1ST DEGREE.—*Simple erythema*, due to increased flow of blood through the dilated vessels. No tissue destruction ensues, and no scar is left.

2ND DEGREE.—*Vesication*, due to the exudation from the dilated capillaries of the cutis causing the superficial layers of the epithelium to be raised from the deeper in the form of blebs. No scar is left, as only the superficial layers of the epithelium are destroyed, and these are soon reproduced from the deeper layers. Some slight staining of the skin, however, may subsequently remain.

3RD DEGREE.—*Destruction of the cuticle and part of the true skin.*—The epithelium around the hair-follicles, in the sweat-glands, and between the papillæ, escapes, and rapidly forms new epithelium over the granulating surface left on the separation of the sloughs. A scar results, but as it contains all the elements of the true skin, the integrity of the part is retained, and hence there is no contraction. It is the most painful form of burn, as the nerve-endings are involved but not destroyed.

4TH DEGREE.—*Destruction of the whole skin.*—The sloughs are yellowish-brown and parchment-like; and their separation is attended by much suppuration. As the nerve-endings are completely destroyed, the pain is much less than in the former degree of burn. The epithelium which covers in the granulating surface is only derived from the margins of the burn, and the resulting scar consists of dense fibrous tissue. Hence the extensive contraction and great deformity which often result.

5TH DEGREE.—*Penetration of the deep fascia and implication of the muscles.*—Great scarring and deformity necessarily follow.

6TH DEGREE.—*Charring of the whole limb.*—The parts are separated by ulceration in the same way as in gangrene.

CONSTITUTIONAL EFFECTS.—When the burn is superficial and of small extent, there may be no constitutional symptoms; and even when it is deep, but limited to one of the extremities, as the foot or hand, they may also be slight. When, however, the burn is extensive, and especially when it involves the chest, abdomen, or head and neck, even although it is only of the first or second degree, the symptoms may be severe, more particularly when the patient is a child. The constitutional effects may be divided into three stages:—1. *Shock and congestion.* 2. *Reaction and inflammation.* 3. *Suppuration and exhaustion.*

1ST STAGE.—*Shock and congestion.*—The shock is often very great, especially when the burn is extensive, and involves the trunk, or head and neck. The patient is pale and shivering, the pulse feeble and fluttering, and the extremities are cold; he suffers little or no pain, and sometimes passes into a state of coma and dies, the chief *post-mortem* appearances being congestion of the internal organs, particularly the brain.

2ND STAGE.—*Reaction and inflammation.*—Reaction comes on from twenty-four to forty-eight hours after the burn. The pulse is full, strong, and rapid, the temperature rises, and there are other symptoms of fever. Inflammation is set up around the burnt part, and there is now danger of the absorption of the septic products derived from the putrefaction of the sloughs which are beginning to separate. The congestion of the internal viscera, so common in the former stage, may run into inflammation; and pleurisy, pneumonia, peritonitis, or meningitis may supervene and prove fatal. Perforating ulcer of the duodenum, which is generally situated near the head of the pancreas, may now occur, and is said to be most frequently met with about the tenth day. It would appear to be more rare, however, than has been generally supposed, since no case has occurred at St. Bartholomew's during the last ten years. It was formerly attributed to Brunner's glands taking upon themselves the function of the injured glands in the burnt skin, but is more likely due to the irritation of the vitiated products secreted in the bile and discharged into the duodenum at the bile papilla.

3RD STAGE.—*Suppuration and exhaustion.*—During this stage, which sets in on the separation of the sloughs, there is still a danger of the patient succumbing to inflammation of the viscera, especially the thoracic; or he may be worn out by hectic and exhaustion from long-continued suppuration. He is also exposed to the risks of secondary hæmorrhage on the separation of the sloughs, and to blood-poisoning from the absorption of septic products unless the greatest care is exercised to prevent the decomposition of the discharges. On cicatrization occurring, horrible deformity may ensue from the contraction of the newly-formed fibrous tissue in the scars.

The *Treatment* must be both local and constitutional.

Local treatment.—The clothes should be removed with the greatest care, so as not to tear off the cuticle; but undue exposure should be avoided. In burns of the first and second degree, the part should be protected from the air and changes of temperature by smearing it with carron oil or vaseline, or dusting it with boric acid, and wrapping it in cotton-wool, the blisters being pricked to relieve tension and to let out the serum. The cuticle, however, should not be removed, as it serves as the best protective. Of late, lint soaked in a saturated solution of picric acid and placed over the burn has been highly extolled. The picric acid is said to have a keratoplastic action, *i.e.*, it is believed to promote the keratinisation of the epithelium. In burns of the third degree, the parts may also be protected by cotton-wool till the sloughs begin to separate.

Decomposition of the discharges should then be prevented as much as possible by mild antiseptic dressings. Thus, the surface may be dusted with iodoform ; or eucalyptus oil, boracic lotion, and the like may be applied. Some surgeons put on a charcoal or even a linseed-meal poultice. Carbolic acid should not be used, as not only is it too irritating, but there is danger of it being absorbed when the burn is very extensive. When the sloughs have separated, and granulation sets in, the wound may be treated as described under simple ulcer, redundant granulations being repressed by nitrate of silver. Skin-grafting is often useful in the fourth degree of burns. The fourth and fifth degrees require the same treatment as the third, but during cicatrization contraction must be as far as possible prevented by the use of elastic tension, extension-apparatus, splints, &c. Later some form of plastic operation to overcome the effects of the contractions will often be required. In the sixth degree, amputation, if a limb is affected, will probably sooner or later be called for.

Constitutional treatment.—If the shock is severe, stimulants in the form of brandy or ammonia should be given according to the state of the pulse, the patient covered with blankets, hot bottles put to the feet, and undue exposure whilst removing the burnt clothes and applying the dressings as much as possible avoided. Opium should be given, especially if there is much pain. As soon as the patient can bear it, fluid nourishment should be substituted for stimulants, as the latter, if given in large quantities, only tend to produce excessive reaction and inflammation. During the second stage, little can be done beyond regulating the bowels and secretions ; lowering treatment is not well borne, at any rate when the burn is extensive and deep, as the patient will then require all his strength to sustain the drain on his system during the casting off of the sloughs and the long suppuration following. The inflammatory fever, moreover, generally assumes, if it is not so from the first, a low type. A stimulating plan of treatment, rather than a depressing, is therefore necessary. In the third stage, the patient's strength should be supported by abundant nourishment and stimulants.

LIGHTNING- AND ELECTRIC-STROKE.—Death may be instantaneous, or the stroke, beyond causing temporary unconsciousness, may do no harm. In some instances, superficial or deep burns, or paralysis of certain nerves, as the optic, auditory, &c., have been produced. Of late, effects similar to those produced by lightning-stroke have occurred from contact either with wires through which electric currents of high intensity were passing, or with electromotor apparatus. Death from contact with such may be due to actual tissue destruction, or to arrest of respiration and asphyxia. In the first case the subject is beyond recovery ; in the latter case death may be only apparent, and artificial respiration continued for some hours may lead to recovery. The *treatment* consists in applying warmth, artificial respiration, and stimulants whilst the patient is in a state of shock or suspended animation. Rhythmical tractions and relaxations of the tongue (the *Laborde method* of treating asphyxia) should be practised by seizing the tongue, drawing it out of the mouth and then letting it fall back, the process being repeated about fifteen or twenty times a minute. The functions of the nerves if paralysed have sometimes been restored by galvanism.

HÆMORRHAGE.

In speaking of the treatment of wounds it was stated that our first care should be to staunch hæmorrhage. This requires different measures according as it is arterial, venous, or capillary. It is therefore first necessary to be able to distinguish between these varieties. Usually it is quite easy. In *arterial hæmorrhage* the blood escapes in jets, the force of which is increased at each systole of the heart, and is of a bright scarlet colour. In *venous hæmorrhage* the blood wells up from the wounded vessel usually in a continuous stream, and is of a dark purplish-red colour. In *capillary hæmorrhage* the blood appears to ooze from all parts of the wound, trickling down its sides to the deeper parts, where it forms a little pool. In some instances, however, as where arterial blood escapes from a deep and devious wound, it may resemble venous blood in that it flows continuously instead of in jets, and when the patient is partially asphyxiated, as from too large a dose of an anæsthetic, it becomes of a dark colour. On the other hand, venous blood exposed to the air in its passage from a deep wound may undergo oxygenation and become bright like arterial. Bleeding from the corpus spongiosum and corpora cavernosa of the penis, or from like tissues consisting of cavernous blood-spaces or numerous small arteries and veins, is sometimes spoken of as *parenchymatous hæmorrhage*. When hæmorrhage occurs in a visceral cavity, as the pleura or peritoneum (*internal hæmorrhage*), or into the substance of the tissues of the trunk or extremities (*extravasation*), it is known by special signs, and is treated of elsewhere.

Constitutional effects of hæmorrhage.—The effect upon the constitution of course varies according to the amount of blood lost, and is more marked when the blood is rapidly poured out from a large artery than when it escapes slowly from a small artery or from a vein. In the former case the patient may die in a few minutes of syncope. When the bleeding is less severe the face and general surface become blanched and cold, and the lips and mucous membrane pallid. The pulse is feeble, fluttering and rapid, and at length only to be felt in the larger vessels. The skin is bathed in profuse perspiration, the respiration is sighing, and the mind wanders. These symptoms may end in syncope, convulsions, and death; or the patient may slowly recover, or may suffer from anæmia or functional disturbance for years. If he is old, some secondary disease is apt to be engrafted on this state of anæmia, of which he may die. Children bear the loss of blood badly, but recover rapidly; the old stand the loss better, but the effect on their constitution is more permanent.

Constitutional treatment of hæmorrhage. When the bleeding has been severe, immediate steps must be taken to prevent fatal syncope; and after this danger has been tided over, we must then seek to counteract the remote effects produced upon the whole system by the loss of blood. 1. *Immediate treatment.*—Our efforts must first be directed to arrest, or at any rate to temporarily control, the hæmorrhage by some of the local measures to be presently described. Having done this, the chief indication is to prevent fatal syncope by ensuring a sufficient supply of blood to the brain to excite the cardiac centre in the medulla oblongata. Thus, the patient should be laid on his back with his head low, his body warmly covered up, and hot bottles placed at his feet and about his trunk; or if the pulse does not improve, stimulants in small quantities should be administered, by the mouth if he can swallow, otherwise by the rectum or by subcutaneous injection; whilst in severe cases the legs and arms should be held up, or an Esmarch's bandage applied to them in order the better to drive the blood to the brain. As a last resource, infusion of a saline solution should be practised. Where the bleeding is internal or cannot be arrested, stimulants should be avoided, inasmuch as the syncope into which the patient has fallen tends temporarily to stop the bleeding by inducing clotting of the blood in the wounded vessels. If the heart be again roused to action by stimulants and the vessels in consequence become dilated, the clots may be displaced, the bleeding re-started, and the last flickering spark of life put out. 2. *To counteract the remote effects* of the loss of blood, fluid nourishment should be given in small quantities, and then eggs, fish, and finally meat. Iron is required to restore the loss of hæmatin, and a sea-voyage or prolonged residence in the country is beneficial in overcoming the anæmia.

Transfusion of blood and infusion of saline solution into the veins.—Transfusion of blood has long been employed in cases where death is threatened from excessive hæmorrhage. It is, however, a dangerous procedure, in that the transfused blood may form clots and thus lead to the plugging of some of the patient's vessels, with possibly fatal consequences. Moreover, it appears that blood is of no more value than an equal amount of any bland fluid, since it has been shown that the transfused blood is merely destroyed and absorbed and the blood-pigment passed with the urine. On the other hand, the infusion of a saline solution has all the advantages of transfusion of blood without its disadvantages and dangers. A normal saline solution (common salt ʒj ; water Oj) at 99° to 120° F. is the most easily prepared, and is best infused into the median basilic vein. The vein is exposed, ligatured below, compressed above by a clamp, opened, and a glass cannula introduced and secured *in situ* by a ligature. The cannula is next connected with an irrigator by a rubber tube, and all air having been carefully excluded the clamp is removed from the vein and several pints (2 to 5) of the solution allowed to flow in. A clean Higginson's syringe connected with the cannula by a rubber tube will answer the purpose on an emergency very well. The object of the infusion is to raise the blood-pressure in the arteries sufficiently to enable the patient to rally. The pulse should therefore be watched and the infusion be continued till the object is attained. I have seen the most marvellous effects follow this treatment, and many successful cases have now been reported. It may be repeated if necessary after a short interval. Where the apparatus is not at hand and the case is urgent, a pint of warm water should be injected into the rectum and prevented from escaping. The fluid is rapidly absorbed from the rectum and acts in a similar manner to infusion into the veins, only somewhat more slowly. The injection may also be made into the loose connective tissue of the axilla with good effect. A half-ounce packet of common salt, *i.e.*, sufficient to make four pints of saline fluid, a Higginson's syringe, a glass cannula, and a length of rubber tube, are desirable additions to the surgeon's bag when severe hæmorrhage is likely to occur at an operation.

THE LOCAL TREATMENT OF HÆMORRHAGE may be considered under the heads of arterial, venous, and capillary hæmorrhage.

ARTERIAL HÆMORRHAGE is spoken of as (1) primary, (2) reactionary or recurrent, and (3) secondary.

1. *Primary hæmorrhage* is that which occurs at the time an artery is wounded, whether by accident or surgical operation. 2. *Reactionary or recurrent hæmorrhage* is that which occurs on the patient recovering from the shock of the wound or operation after the primary hæmorrhage has stopped, and may be regarded as a failure in the process for the temporary closure of the vessel. The term recurrent, therefore, should only be applied to hæmorrhage occurring within twenty-four hours of the injury. 3. *Secondary hæmorrhage* is that which occurs any time after the first twenty-four hours, and is due to the failure of the process for the permanent closure of the vessel. The treatment in each case is different.

(1.) PRIMARY ARTERIAL HÆMORRHAGE.—The older surgeons resorted to very barbarous methods of controlling hæmorrhage, such as plunging stumps after amputation into boiling pitch, or operating with a red-hot knife, and it was not till Nature's method of arresting bleeding had been intimately studied, both in the human subject and by experiments on animals, that the local treatment of hæmorrhage was placed upon a scientific basis. It may be best, therefore, first to consider *Nature's method of controlling hæmorrhage* before describing the surgical measures which have been founded upon it. When an artery of small or moderate size is completely divided, the cut end, in consequence of the injury stimulating the muscular fibres of the middle coat, *contracts*, thus lessening the size of the orifice, and, in the case of the small arteries, completely closing it. At the same time, the cut end, owing to the normal elastic tension of the artery, *retracts* within its sheath, leaving the surface of the latter rough and uneven. The diminution in the size of the orifice retards the escape of blood. The slowed current passing over the divided wall of the artery and the roughened internal surface of the sheath, in consequence of this multiplication of points of contact and exposure to the air, coagulates, gradually blocks up the orifice, and fills the sheath around and beyond the retracted end of the artery, forming what is called the *external clot*. The stream having been thus slowed or stopped, the blood inside the vessel also coagulates, and the coagulation spreading from the clot that blocks up the orifice to the first collateral branch, forms what is called the *internal clot* (Fig. 30). When the hæmorrhage has been severe, two other factors favour the formation of these clots, viz. (1), the enfeeblement of the heart's action induced by the tendency to syncope, and the consequent diminished force with which the blood is propelled from the divided vessel; and (2) the increased tendency of the blood to coagulate owing to an alteration in its composition caused by the absorption of watery fluid from the tissues to make up for the amount of blood lost by the hæmorrhage. Thus the hæmorrhage is arrested, and still presuming that the vessel be of a small or a medium size, it may not recur, and Nature will permanently close the wounded vessel in the way to be presently described. It is only, however, when the vessel is small, that Nature can be thus trusted. When a large vessel is wounded, she is quite impotent to prevent an immediately fatal issue; whilst if the vessel is of medium size, as the syncope passes off, and the heart again begins to act with vigour, the clots may be washed away and the bleeding recur till fainting once more ensues.

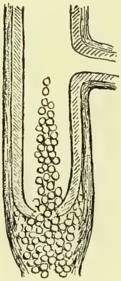

Fig. 30.—Diagram of a wounded artery closed by clots.

In this way bleedings, alternating with temporary arrests, exhaust the patient's strength, till he finally succumbs to fatal syncope.

The method by which Nature permanently closes the vessel is as follows:—The clot between the artery and the sheath prevents the artery from dilating on the cessation of the contraction of the muscular fibres of the middle coat; whilst the internal clot acts, so to speak, as a buffer, and thus prevents the force of the blood-stream being exerted to its full on the end of the vessel while healing is taking place. The injury inflicted on the coats of the vessel by its division sets up a traumatic inflammation. Leucocytes and serum escape from the vasa vasorum of the divided vessel-walls and tissues about the cut end of the vessel, whilst there is proliferation of the endothelial and connective-tissue cells from the margin of the torn coats of the vessel. The cells thus formed gradually permeate both the internal and external clots so that the end of the artery in a few hours becomes surrounded by a small mass of coagulable and cellular exudation. The artery at the same time contracts on the internal clot, which gradually loses its red colour as it is invaded by the inflammatory exudation. New vessels grow out from the vasa vasorum of the arterial wall and from the granulation-tissue about the cut end of the vessel, and invade the inflammatory exudation, which has now replaced the internal clot. Thus the internal clot, instead of as at first being merely adherent by its base to the end of the divided artery, is now intimately blended with the arterial walls, forming a plug of vascular granulation-tissue. The granulation-tissue is next converted into fibrous tissue, which gradually contracts and obliterates the newly-formed vessels, till finally the internal clot, together with the artery, is converted as far as the first collateral branch into a firm fibrous cord. Similar changes, in the meanwhile, occur in the external clot, and it is finally blended with the scar-tissue formed by the healing of the wound of the soft parts around the injured artery.

When an artery is divided in its continuity, the healing of the distal end is accomplished in a similar manner, except that the internal clot in the distal end is often less perfectly produced, and may not be formed at all. Consequently, secondary hæmorrhage is more frequent from the lower than from the upper end of a ligatured artery.

The above description applies chiefly to a complete division of an artery. When an artery is merely punctured, the arrest of hæmorrhage will depend upon the size of the vessels, and the size and direction of the puncture. A wound, however small, of the aorta, or vessel next removed in size, will probably be fatal. In a vessel of less magnitude, when the puncture is small, a clot forms of an hour-glass shape, thus blocking up the wound, and healing occurs by adhesive inflammation. A somewhat larger wound, when made longitudinally to the artery, may heal in the same way; but when made transversely to the axis of the vessel, it assumes a diamond shape, in consequence of the elastic tension of the coats, and the hæmorrhage will probably not be arrested.

THE SURGICAL METHODS OF ARRESTING HÆMORRHAGE may be considered under the heads of temporary and permanent methods.

1. *Temporary methods.*—The surgeon, if the bleeding point is within reach, need never fear hæmorrhage, as mere pressure with the finger will control it, whatever the size of the vessel, till he can obtain the means of permanently arresting it. The pressure may be made directly on the bleeding point, or between the wound and the heart; in the former situation with the finger, pressure-forceps, or the tourniquet; in the latter situation with the finger or the tourniquet, the pressure being then made in such a direction as to press the artery against some resisting structure, as a point of bone. The tourniquets employed are various (Fig. 31 and Fig. 32). The rubber tube of the Esmarch's apparatus perhaps answers the best. An impromptu tourniquet may be made by tying a pocket-handkerchief loosely round the limb, and twisting it up tightly with a walking-stick or umbrella. These temporary means, however, should only be trusted to until more permanent methods can be applied.

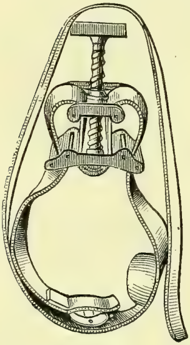

FIG. 31.—Petit's tourniquet.

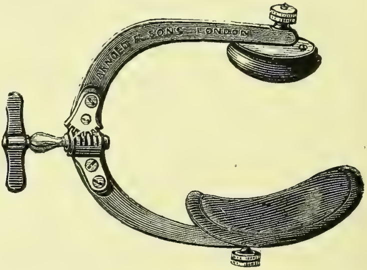

FIG. 32.—Signoroni's tourniquet.

2. *Permanent methods.*—The agents employed for permanently arresting hæmorrhage are—1. *Cold*, 2. *Heat*, 3. *Pressure*, 4. *Styptics*, 5. *Cautery*, 6. *Ligature*, 7. *Torsion*, 8. *Acupressure*, 9. *Forcipressure*.

1. COLD is only applicable to stopping hæmorrhage from small vessels. It acts by causing the muscular coat to contract, thus promoting the coagulation of the blood in the arterioles and capillaries. It is frequently employed in the form of cold water or

ice to arrest bleeding from the smaller vessels in operation wounds, and is a well-known domestic remedy for checking epistaxis, &c.

2. HEAT in the form of hot water is now often employed in place of cold water in large operation wounds, as cold applied to a large surface tends to increase the shock of the operation. The water must be hot (110° to 120°); warm water merely encourages the hæmorrhage by washing away the coagula blocking the vessels. Heat, like cold, acts by stimulating the muscular fibres of the vessel to contract. Superheated steam directed on the bleeding part through a metal tube has been employed of late in place of ligature, &c. It would appear to be a useful method in arresting hæmorrhage from erectile structures as the urethral bulb and from parenchymatous organs as the spleen or liver.

3. PRESSURE as a temporary means of arresting hæmorrhage has already been mentioned. Firmly applied to the flaps covering a wound, it is an efficient method of controlling the bleeding from the numerous small vessels necessarily divided in operations. In the form of a plug or tampon it is the best means at our command in certain situations where the artery cannot be secured by more reliable methods, as the rectum, vagina, tonsil, nose, socket of a tooth, interior of bone, &c. It is, moreover, frequently employed to stop hæmorrhage from a moderate-sized artery where such can be pressed against a bone, as in the scalp; whilst in the form of a graduated compress it was formerly applied to wounds of the palmar arch. Pressure acts mechanically by closing the vessel.

4. STYPTICS arrest hæmorrhage by inducing the coagulation of the blood. Those most in use are perchloride of iron, hamamelis, and nitrate of silver. Of the perchloride of iron, the strong liquor and the solid form are the most efficient preparations. Styptics may be most usefully employed in conjunction with pressure in cases where the latter alone has proved ineffectual. The objection to their use is that they are apt to cause inflammation and sloughing of the tissues, and consequently secondary hæmorrhage is liable to occur on the separation of the slough. A few years ago a case came under the care of a colleague in which two inches of the median nerve were destroyed by the sloughing following the application of perchloride of iron to a wound of the brachial artery. Styptics should never be used where more efficient and safer means of arresting hæmorrhage can be adopted. A new styptic, consisting of a solution of fibrin ferment (1 to 10) to which calcium chloride 1 p. c. has been added, is said to act only on the blood, not on the tissues, and to be perfectly aseptic. It was found by Mr. Wright to be effectual in arresting hæmorrhage after the division of all the veins except the common jugular in a dog's neck.

5. THE CAUTERY arrests bleeding in part by causing the muscular coat of the artery to contract, in part by inducing coagulation of

the blood, and in part by charring the tissues and so producing an eschar which checks or prevents the flow of blood. The wound should be first dried by pressure with lint, and then immediately touched lightly with the cautery, which should be at a dull red heat, as, if used hotter than this, it simply destroys the tissues without producing the above effects, and the hæmorrhage continues. It may be applied in the form of the cautery-iron, which is simply heated in the fire; but Paquelin's benzoline cautery and the galvano-cautery are much more convenient. The chief objection to the use of the cautery is that it causes destruction of the tissues around, and on the separation of the resulting eschar secondary hæmorrhage is liable to ensue. The cautery should never be used in a clean-cut wound.

6. LIGATURE is the most reliable method of permanently arresting hæmorrhage, and is the one most frequently employed. Silk, carbolized and chromicized catgut, kangaroo-tail-tendon, and ox-aorta are the materials chiefly used as ligatures. Of these silk, if rendered aseptic in the way mentioned at page 99, answers admirably for securing the cut ends of arteries in amputation and other wounds. For the ligature of arteries in their continuity, the choice of ligature is still open to question, and will be referred to again under *ligature of arteries*. Whatever form of ligature is used it should not be too thick, or the internal and middle coats will be unevenly divided or may escape division altogether. At the same time it should be strong enough to resist absorption or softening till the artery is securely sealed. It should be tied tightly till the internal and middle coats are felt to yield, but not so tightly as to cut through the external coat. Messrs. Ballance and Edmunds, as the result of an experimental inquiry on the ligature of the larger arteries in their continuity, have advocated that two ligatures should be applied so as merely to occlude the lumen of the vessel, without dividing the internal and middle coats. These observations, however, can hardly apply to the ligature of the cut end of arteries in wounds, as unless the ligature is applied tightly to such there is, obviously, danger of its slipping. An artery is tied in an open wound by seizing the cut end with nibbed forceps (of which Fig. 33 is one of the best forms), drawing it gently from its sheath, throwing a ligature round it, and then tying the ligature in a reef-knot (Fig. 34, A). Both ends of the ligature are then cut off short.

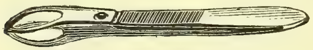

FIG. 33.—Artery forceps.

Effects of ligature.—When a ligature is properly applied the internal and middle coats are evenly and transversely cut through by its pressure. Their cut edges retract and curve within the canal of the vessel, and the external coat, crumpled up and tightly embraced by the ligature, retains the two inner coats in contact with each other (Fig. 35). A clot of conical shape forms in the vessel, extending from the seat of ligature to the first collateral branch, and subsequently becomes adherent by its base to the wall of the vessel. The cut ends of the internal and middle coats unite by adhesive inflammation. When an aseptic ligature is used, and the wound runs an aseptic course, the ligature becomes embedded in the granulation-tissue and, if of animal material, absorbed, or in the case of silk, encysted. The permanent closure of the artery is accomplished by the process already described under *Nature's method of controlling hæmorrhage* (p. 114).

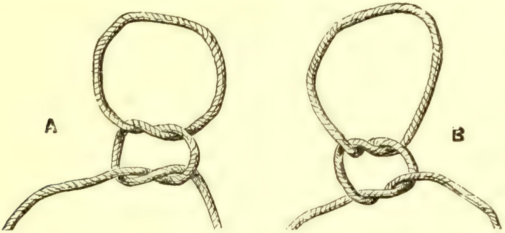

Fig. 34.—A. The reef-knot *versus* B, the granny-knot.

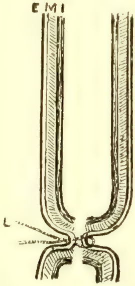

Fig. 35.—Diagram of a ligatured artery. E. External; M. Middle; and I. Internal coat. L. Ligature.

7. Torsion consists in seizing the artery firmly with the torsion-forceps (Fig. 36), drawing it gently from its sheath, and twisting it sharply several times in its long axis till the internal and middle coats are felt to yield. The process resembles the tearing across of an artery, such as occurs in the avulsion of a limb. When torsion is successfully performed, the internal and middle coats are ruptured and bent upwards into the lumen of the artery, and the external coat is twisted up into a cone (Fig. 37). A clot then forms, and the artery heals permanently in the way already described. It appears to be a reliable method, but takes a longer time in its performance than ligature.

8. Acupressure consists in securing the end of the bleeding artery by pressing it between an acupressure needle (which resembles a hare-lip pin) and the tissues, or between the needle and a wire twisted over the needle. This method is scarcely ever used now.

9. Forcipressure consists in seizing the bleeding artery, and the surrounding tissues if the vessel is small, with Spencer Wells' pressure-forceps, leaving them on a few minutes and then very

gently withdrawing them. It is a means often used to control the hæmorrhage during an operation, and will even permanently arrest it in the case of the smaller vessels, which are often found not to bleed when the forceps are removed. It is sometimes employed for arresting hæmorrhage from a vessel which from its depth or other cause cannot be tied. In such a case the forceps are left on from twelve to twenty-four hours, and at the end of that time are very gently removed so as not to re-start the bleeding.

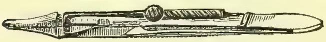

FIG. 36.—Torsion-forceps.

(2.) RECURRENT, REACTIONARY, OR INTERMEDIARY HÆMORRHAGE is that which may come on within the first twenty-four hours after a wound as the patient gets warm in bed, and the shock of the operation or injury has passed off. It may be regarded as a failure in the process of the temporary closure of the vessel. It should be noted that the term recurrent is by some authors applied to what is here called secondary hæmorrhage. *Causes.*—1. Slipping of a ligature or displacement of a clot from a vessel consequent upon the wounded parts not being kept at rest. 2. Washing out of a clot from a vessel which it has temporarily plugged, by the increased force of the circulation as the heart regains power on the passing off of the syncope or shock. It is not uncommon in large wounds to have some oozing of blood through the dressings; but this should not be considered as recurrent hæmorrhage unless it occurs in unusual quantities, and only then calls for treatment. The soiled dressings having been covered with fresh layers of the antiseptic gauze and wool, the part should be firmly but gently bandaged and then elevated. This failing, the dressings must be removed, and the flaps in the case of an amputation separated, the clots washed away with cold or hot water containing an antiseptic, and any vessel found bleeding, tied. The wound should be then re-dressed and firm pressure applied.

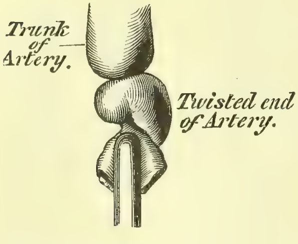

FIG. 37.—Effect of torsion on an artery.

(3.) SECONDARY HÆMORRHAGE is that which occurs after the period of reaction has passed in consequence of the failure of the process for the permanent arrest of hæmorrhage. Owing to the improved treatment of wounds, it is now very rare.

Cause.—Secondary hæmorrhage is due either to the defective formation of the internal clot, or to the failure of union of the internal and middle coats. Either of these, again, may be (*a*) the result of some fault in the surgical means taken to arrest the primary hæmorrhage, and then in some measure may be said to be preventable; or (*b*) the result of some disease of the vessel or constitutional state of the patient, and then may usually be regarded as non-preventable. These causes may be considered under the following heads:—

1. *Defect in the ligature or in its application.*—(*a*) An improperly prepared animal ligature may become absorbed too soon. (*b*) A non-absorbable ligature, if chosen, may be too thick or tape-like, and hence not divide or unevenly divide the internal and middle coats. (*c*) The ligature may not be aseptic, and so cause suppurative instead of adhesive inflammation. (*d*) The ligature, whatever kind is used, may be tied too tightly or too loosely, or be unevenly knotted. (*e*) The sheath in applying the ligature may be too freely separated from the artery, or the artery bruised during the separation of the sheath. (*f*) The ligature may be placed too near a collateral branch.

2. *Defect in the management of the wound.*—The tissues may be roughly handled and bruised, or the wound may be imperfectly drained and the discharges allowed to become septic or infected by pathogenic organisms, so that, in either case, septic inflammation and suppuration may be set up and spread to the vessel and its contained clot.

3. *Disease of the vessel-walls.*—Under this head may be mentioned atheroma, calcareous degeneration, and syphilitic and tuberculous disease, all of which may either allow the ligature to cut its way too quickly through the diseased coats, or prevent the adhesion of the internal and middle coats and the other changes that should occur in the normal process of healing.

4. *Constitutional conditions.*—These are such as render the blood less coagulable than usual, or are associated with an increase of the blood-pressure or an excited action of the heart. Amongst such conditions may be mentioned the hæmorrhagic diathesis, diabetes, Bright's disease, septicæmia, pyæmia, traumatic fever, and plethora.

Symptoms.—There may be a sudden and even fatal gush of blood, or previous to this, the discharge from the wound may have been blood-stained. In some cases, the bleeding may stop for a time, but again and even again recur till the patient finally sinks from exhaustion. Sometimes the hæmorrhage may cease spontaneously after one or more bleedings, and the patient recover.

Treatment.—A. *From an artery in a stump after operation.*—The treatment will differ according to (1) the date at which the hæmorrhage occurs; (2) whether it is from the main artery; (3) the condition of the stump; and (4) the situation of the amputation. Thus, when the hæmorrhage occurs *a few days* after the operation, and is little more than a mere oozing, elevation and pressure by careful bandaging will often stop it. If it should not do so, or the bleeding is more severe and appears to come from the main artery, a tourniquet applied to the artery above may succeed. This failing, or the flaps appearing distended with blood, the wound should be opened up, the clots removed, and the bleeding vessels secured. At a *later period*, when the healing process has considerably progressed, should pressure fail, it becomes a question whether the healing flaps should be torn apart and the artery secured at its bleeding point, whether the main artery should be tied above the wound, or whether re-amputation should be performed. If the main artery can be easily secured just above the operation wound, this is to my mind the proper procedure, especially if the wound is in a sloughy condition, in which case the ligature would probably not hold at the seat of bleeding. This is also the right course to pursue if the amputation has been performed at the shoulder or hip-joint; but if in the lower third of the leg or in the fore-arm, then an attempt should be made to tie at the wound, or if this is impossible from the sloughy condition of the stump, re-amputation is probably the safest treatment.

B. *From an artery in its continuity.*—Pressure should first be applied at the seat of wound, and in the case of one of the extremities for a considerable distance over the course of the artery, both above and below the wound, and the whole limb bandaged from the foot or hand, as the case may be, upwards. This treatment failing after a thorough trial of it has been made, the best plan, as a rule, is to cut down upon and tie both ends of the bleeding artery in the wound. Tying the main artery at a distance above the wound has been advised, but is open to the objection that the secondary bleeding often comes from the distal end of the artery; and that even when it comes from the proximal end, the ligature of the main vessel may not control it, since blood may be carried into the artery below the ligature by collateral branches (see Fig. 58, p. 191). Further, in the case of the lower extremity there is also a danger of gangrene. The operation of tying at the seat of wound is no doubt difficult, as the parts are generally matted together or in a sloughy condition, and the coats of the artery so softened that a ligature will not hold; but by following the artery a little way upwards and downwards, a healthy portion may be found whereon to place the ligature. The steps of the operation are greatly facilitated by the use of Esmarch's bandage. When the hæmorrhage comes from an artery deeply placed, as the external iliac or subclavian, pressure is probably our only resource. In the case of the iliac, an attempt might be made to secure it at the bleeding spot. In the only instance, however, in which I have seen it tried it was unsuccessful. Should hæmorrhage recur after both ends of the artery have been tied at the seat of wound, amputation in the case of the lower extremity is probably the safest course.

VENOUS HÆMORRHAGE.—When a vein is cut completely across, the arrest of hæmorrhage is due chiefly to the formation of a coagulum in its interior, but partly to the collapse of the vein. *Treatment.*—Unless a large vein is wounded in its continuity, no treatment beyond pressure is usually required. Should the main vein bleed after an amputation a ligature should be applied to it. See *Treatment of Wounded Veins.*

CAPILLARY HÆMORRHAGE is arrested by the formation of coagula in the capillaries and smaller arterioles. The coagulation is due in part to the exposure of the blood to the air; in part to the traumatic inflammation set up in the capillary wall by its division; and in part to the diminished force of the circulation in the capillaries consequent upon the reflex contraction or even closure of the arterioles which follows the division of the tissues. *Treatment.*—As the hæmorrhage usually stops spontaneously, nothing in the way of treatment is, as a rule, called for. Cold or hot water, however, may be used to more quickly cause its cessation; and firm pressure on bringing the wound together will also check it.

CONSTITUTIONAL EFFECTS OF INJURY.

SHOCK is a general lowering of the vital powers induced by a severe impression made directly on the nerve-centres, or indirectly through the peripheral nerves.

The *causes* of shock may be divided into the predisposing and the exciting. Certain conditions prior to an injury or an operation tend to make the shock more severe, and may therefore be regarded as *predisposing* causes. Such are Bright's disease, hepatic and cardiac mischief, a highly nervous and hysterical temperament, enfeeblement from old age, sedentary occupation, excessive fear of the operation, &c. Among the *exciting* causes may be mentioned mechanical injuries, especially of important parts or organs, as the abdomen, testicle, &c., burns and scalds, especially when extensive and involving the trunk, serious operations, particularly when prolonged, undue exposure of the body to cold, as during a long operation, bites of venomous reptiles, the action of some irritant poisons, the sudden emptying of an over-distended bladder, &c. Powerful mental emotions, as sudden fright, grief, or joy, are sometimes sufficient of themselves to produce severe and even fatal shock. In fatal cases of shock from such causes, however, some visceral disease has generally been discovered. Fright, moreover, adds to the shock produced by mechanical injury, as seen for example in railway accidents, burns from the clothes taking fire, &c.

Pathology.—But little is found *post-mortem* in fatal cases of shock. The right side of the heart and the venous system generally, especially the abdominal veins, may be engorged with blood, and the nerve-centres anæmic. Sometimes the heart has been found empty, and if the shock has been combined with severe hæmorrhage there may be a general deficiency of blood in the body. The impression produced by the injury, operation, or mental emotion on the nervous centres, is believed either—1, to lead to paralysis of the heart directly through the pneumogastric nerves; or 2, to induce through the splanchnics a vaso-motor paralysis of the walls of the abdominal veins, whereby they become engorged, and the nerve-centres and heart in consequence imperfectly supplied with blood; hence, partly owing to deficient nervous stimulus, and partly to lack of sufficient arterial blood to the heart's substance and ganglia, cardiac paralysis ensues.

The *symptoms* vary considerably in severity. In extreme cases the patient lies in a semi-conscious state. His pulse is feeble, frequent, and fluttering, perhaps hardly perceptible at the wrist. The surface, especially that of the extremities, is cold, the temperature falling at times to 97°, or even 96°; the face is pale; the lips are blanched; the skin is moist or covered with a clammy sweat; the eye is half closed, and lustreless or glazed; and the respiration is shallow, and may be barely perceptible. There is marked muscular relaxation; there may be yielding of the sphincters, and at times nausea and vomiting. The symptoms may gradually increase, and the patient die of syncope or asthenia; or he may gradually rally and pass into the condition known as *reaction*. The pulse will then become full and increased in frequency, the temperature slightly raised, the face flushed, the skin hot and dry, the urine scanty and high-coloured, the tongue furred, and the bowels confined. Many of the feverish symptoms, however, that were formerly regarded as the result of excessive reaction, are now known to be due to septic poisoning.

Treatment.—In slight cases, beyond covering the patient up warmly in bed with blankets, and applying hot bottles to the feet, nothing is required, except when there is much pain a subcutaneous injection of one-fifth of a grain of morphia. In severe cases, small and repeated doses of brandy should be given, carefully watching its effect upon the pulse so as not to subsequently induce excessive reaction; whilst hot bottles should not only be applied to the feet, but placed on either side of the thorax, and friction used to the hands and surface generally. If there has been severe hæmorrhage, fluid nourishment in small and oft-repeated doses should be administered with the stimulant. In extreme cases, where the patient is unable to swallow, brandy should be administered by the rectum, and a pint of hot water, or better, hot saline solution (100° to 120°F.) should be introduced into that cavity, or ether or strychnine (gr. $\frac{1}{80}$)

injected subcutaneously; whilst, should the breathing cease, artificial respiration ought to be employed and persevered in for some time, although at first it may apparently be ineffectual. The application of heat by means of hot bottles and warm blankets must, in the meantime, on no account be neglected. Hot flannels placed over the cardiac region may be successful in rousing the flagging heart; and in the case of a child a hot bath may be given. Should the jugular veins be distended, indicating an over-full and partially-paralysed condition of the right side of the heart, the external jugular vein may be opened. On the other hand, if there has been excessive hæmorrhage, infusion of saline solution should be performed, the extremities in the meantime being raised and bandaged so as to impel as much blood as possible to the nerve-centres and imperfectly-distended heart. Electricity in some cases has been useful.

TRAUMATIC FEVER.—After every injury, when severe, the temperature, even when there is no wound, as in some cases of simple fracture, may rise one or two degrees, but falls to normal about the third day, whilst the tongue may become slightly furred, the bowels confined, the appetite lost, and the pulse increased in frequency. These symptoms, however, pass off with the fall of temperature, and, for the rest of the period while the wound or injury is healing, the patient's general functions are performed naturally. This condition appears to depend in part upon an impression made through the peripheral nerves on the heat-regulating centre in the medulla, and in part upon the absorption of the products of cell destruction which occurs during the process of the simple traumatic inflammation resulting from the injury. This *simple form of traumatic* fever must be carefully distinguished from the *infective* and *septic*, which depend on the absorption of the toxins of pyogenic organisms in the one case, and of the products of fermentation or putrefaction from a septic and imperfectly-drained wound in the other case. If the wound is allowed to become infected or septic, the symptoms of simple traumatic fever pass into those of the infective form, or if the dose of poison absorbed has been large, into those of sapræmia. Simple traumatic fever subsides of itself, and requires no special treatment beyond relieving the bowels by a gentle purgative, and keeping the patient on slop diet. *Septic and infective traumatic fever* will be described under septic processes in wounds.

TRAUMATIC DELIRIUM is the term applied to the delirious state which sometimes supervenes after injuries and surgical operations. The delirium may depend upon several distinct conditions. Thus (1) it may be merely a symptom of infective or septic traumatic fever, and is then known as *inflammatory* or *septic traumatic delirium*. (2) It may occur in the highly nervous or neurotic as the result of severe mental strain or exhausting brain-work previous to the injury or operation, being then spoken of as *nervous traumatic delirium*. (3) It may be the result of the long-continued abuse of alcohol, and is then ordinary *delirium tremens* brought on by the accident or operation. These various forms, however, no doubt often occur together.

Inflammatory traumatic delirium.—Of this variety little need be said further than that it generally occurs from the third to the fifth day, when the septic traumatic fever is at its height, and that it usually begins or is worse in the night and abates with the morning remission of temperature. The *treatment* is that of septic traumatic fever with the addition of an ice-cap to the head when the delirium is high.

Nervous traumatic delirium, though rare, sometimes occurs in subjects of a susceptible nervous temperament or over-exhausted with brain-work. It is unaccompanied by fever and closely resembles delirium tremens, except that it is not due to alcoholism. The delirium, which is usually of a low and muttering, but occasionally of a violent or maniacal character, usually yields to quiet and opium, or bromide of potassium and chloral, with careful feeding and the judicious employment of stimulants where such are indicated.

Alcoholic traumatic delirium or delirium tremens differs from the inflammatory variety in the absence of fever, and in the peculiar nature of the delirium, which is of a low muttering or busy kind. The patient has delusions, fancies that he sees animals or devils under his bed or chair, is suspicious of his friends, talks constantly to himself, answers rationally when spoken to, but immediately relapses into his incoherent muttering state. Sometimes the delirium is of a violent character, the patient will not remain in bed, and may attempt to destroy himself or those around him. The temperature is normal or but slightly raised; the skin is perspiring; the hands are tremulous; the pulse is full, soft, and often quickened; the tongue is also tremulous, indented by the teeth, and coated with a creamy fur, and in severe cases becomes dry and brown. The bowels are usually confined. The patient cannot sleep, and will not of his own accord take food, but will, as a rule, drink anything.

The *prognosis* is good when the patient is young, and can be induced to take food; but when he is broken-down in health or the subject of visceral disease he usually sinks into a state of asthenia, and dies of exhaustion, or it may be of heart failure during a paroxysm of violence.

Treatment.—The chief indications are to make the patient take food and to procure sleep, and so restore power to the exhausted nerve-centres. Thus, the digestive functions should be regulated by clearing the bowels with a purgative or an enema, and by the subsequent administration of tonics, such as quinine. The difficulty in getting the patient to take food may generally be overcome by a judicious mixture of firmness and coaxing, otherwise he must be fed by an œsophageal tube. The diet should consist of fluid nourishment given in small and repeated quantities by night as well as by day, provided the patient is awake. To procure sleep subcutaneous injections of morphia (gr. $\frac{1}{5}$), or bromide of potassium and chloral in doses of twenty grains of the former to fifteen of the latter, may be given every two hours, carefully watching their effect. Hyoscine (gr. $\frac{1}{300}$ to $\frac{1}{100}$) will often cause sleep in a few minutes. Success has sometimes been obtained by first inducing insensibility by chloroform, and following up its effects by the subcutaneous injection of morphia. This plan is, however, by no means free from danger, since three deaths occurred at St. Bartholomew's alone in seven years. If there is kidney disease, morphia and opium should not be given at all, or with great caution. The question of the administration of stimulants is one on which surgeons differ. Perhaps the best rule is—where the patient is young and of good constitution, to withhold them entirely; but where he is old, broken down in health, or the subject of visceral disease, to give them in moderate quantities, regulating the dose according to the amount of depression and the effects produced. If he is violent or noisy he must be placed in an isolation-ward, and prevented from injuring himself or his attendants, either by the use of the strait-jacket or by manual restraint. Seclusion itself has often a good effect in producing sleep. The management of a local injury is often rendered very difficult by the patient tearing off bandages, splints, &c., and thus, for example, converting a simple fracture into a compound one. Such mischief can only be prevented by the greatest watchfulness and care.

DISEASES THE RESULT OF SEPTIC AND INFECTIVE PROCESSES IN WOUNDS.

The diseases included under this head may be divided into two chief classes, the *septic* and the *infective*.

The SEPTIC are such as depend upon putrefaction, whereby certain chemical products are formed and set up local inflammation, and if absorbed into the system through the blood- or lymph-channels, give rise to fever and other constitutional symptoms known as blood-poisoning. The chemical nature of these products is unknown, but some of them are believed to be of the nature of ptomaines, and to act on the tissues locally, or on the whole system if absorbed, as intense irritants, and in a manner similar to that in which certain known alkaloidal bodies do. Thus, they do not multiply in the body beyond the seat of lesion, and the effects to which they give rise are proportionate to the dose absorbed; and as soon as the putrefactive processes in the wound, or the absorption of their products, are prevented, the local inflammation and the constitutional symptoms cease. The poison absorbed is non-infective: that is, if an animal is inoculated with the blood of another suffering from a septic disease, the disease is not transmitted; neither is there evidence of one patient being able to infect another. Micro-organisms are not discovered in the blood or tissues outside the seat of lesion during life, nor immediately after death. The poison, however, is manufactured by living micro-organisms, belonging to the group of saprophytic bacteria. These saprophytic or putrefactive organisms are capable of growing on dead or dying tissues, but cannot thrive in healthy or living tissues, so that they cannot spread beyond the seat of lesion. If the diseased area be properly removed, the micro-organisms are also removed, and if the patient is sufficiently strong to resist the dose of poison already absorbed, recovery will soon follow. In a septic process, therefore, there is (1) infection of the injured, dead or dying tissues with saprophytic (putrefactive) organisms, and (2) intoxication with the poison elaborated at the seat of lesion. A good example is an ordinary case of gangrene, where a limb dies from malnutrition :—The dead or dying limb becomes infected by putrefactive organisms which cause the decomposition of the part. These produce poisons which are absorbed and lead to fever and other constitutional disturbances. Amputation beyond the diseased part in a good subject is soon followed by recovery, for the micro-organisms, being saprophytic, cannot live beyond the line of demarcation.

The INFECTIVE diseases, on the other hand, depend upon an infection with parasitic organisms, *i.e.*, bacteria capable of thriving in living tissues. Generally speaking, so far as wound infections are concerned, these belong to the group of pyogenic organisms, but there are a number of special infective diseases produced by special organisms. Thus the diphtheria bacillus, the actinomyces fungus, the tetanus bacillus, the anthrax, glanders and tubercle bacilli, severally produce their own characteristic lesions and diseases. In all infective processes, there must also be intoxication: the organisms elaborate their toxins, and these are absorbed either by the lymph-channels or the circulation. The difference between septic and infective lesions is this, that in the former the infection and intoxication are saprophytic, in the latter parasitic. An infective process may be local or general: if local, the organisms are restricted to the seat of lesion, *e.g.*, tetanus, diphtheria, erysipelas and gonorrhœa; if general, the organisms find their way into the circulation (hæmic infection). But when the process is local the intoxication may either be slight, leading to hardly more than mild constitutional disturbances; or the intoxication may be very severe, so that the symptoms may be general and serious. Tetanus and diphtheria, for instance, are local infections accompanied by intense general intoxication. The infective micro-organisms may be divided into two chief classes: (1) the *non-specific*, or the pyogenic bacteria, which, if admitted into the wound, may merely set up local inflammation or suppuration, or if introduced into the system may, under certain conditions, lead to septicæmia or to disseminated suppuration through the body (*Pyœmia*); and (2) the *specific* or the true infective micro-organisms, as the bacillus of anthrax, which, when introduced into the tissues or system, set up a like disease to that from which the subject they were taken from was suffering. Micro-organisms in large numbers are often found in the blood and in the tissues immediately after death.

Both septic and infective diseases may occur simultaneously in the same subject. Thus, an *infective* micro-organism, as the *Streptococcus pyogenes*, may set up a localized infective inflammation in the wound, and the toxic products of this may be absorbed into the system. *Saprophytic* organisms may now contaminate the wound and their septic products be absorbed as well, producing a septic intoxication; or acting in the wound or in the system at large they favour the growth and development of the infective organisms.

These diseases, whether *septic* or *infective*, may be divided into the local and the general: that is, the poison may set up local mischief, which may or may not be followed by general poisoning of the system; or the whole system may be primarily affected, any local mischief that may occur in the wound being merely of secondary consequence. It must, however, be remembered that a small local lesion may for some reason or another become general. Thus a boil may become a carbuncle, and this again may progress to a phlegmonous or gangrenous inflammation, and eventually culminate in septicæmia and pyæmia. Similarly a tuberculous joint or gland, which is a local infection, may with unexpected suddenness lead to a general miliary tuberculosis.

Classification of septic and infective diseases:—

I. SEPTIC DISEASES. — (A) *Local.* — 1. Septic inflammation. (B) *General.*—1. Septic traumatic fever, and 2. Sapræmia or septic intoxication.

II. INFECTIVE DISEASES.—(A) *Local.*—(*a*) *Non-specific.* 1. Suppuration; 2. Cellulitis; 3. Hospital gangrene; 4. Wound-diphtheria. (*b*) *Specific.*—1. Cutaneous erysipelas; 2. Phlegmonous erysipelas; 3. Gonorrhœa; 4. Malignant pustule; 5. Actinomycosis; 6. Tuberculosis; 7. Glanders. (B) *General.*—(*a*) *Non-specific.*—1. Septicæmia with or without pyæmia. (*b*) *Specific.*—1. Hydrophobia; 2. Some forms of Tuberculosis; 3. Some forms of Leprosy; 4. Some forms of Glanders; 5. Tetanus; 6. Diphtheria; and 7. Some forms of Anthrax-poisoning.

General Septic Diseases.

SEPTIC TRAUMATIC FEVER is the result of the absorption of a moderate dose of the chemical products of putrefaction or decomposition from a septic or imperfectly-drained wound (see *Septic inflammation*). It begins usually about the second or third day after the wound, whether this be the result of injury or of operation, with a feeling of chilliness or a distinct rigor. The temperature runs up to 102° or 103° or higher, with morning remissions, the pulse is increased in frequency, the skin is hot and dry, the urine is scanty and high-coloured, the tongue is furred, the appetite is lost, the bowels are confined, and the patient complains of headache and general feeling of malaise, and is at times delirious. The symptoms, which are generally at their height about the sixth or seventh day, may subside as suppuration is established and the further absorption of septic products is prevented by the sealing of the tissues with the inflammatory exudation and the formation of granulation-tissue. If the absorption of septic products continues in small quantities the fever may run into hectic, or, if the dose of poison is increased, into sapræmia. The *treatment* consists in at once rendering the wound aseptic and thoroughly draining it, the bowels in the meantime being opened by a brisk purge, and slop diet continued.

SAPRÆMIA, OR SEPTIC INTOXICATION, which has hitherto been included with septic infection under the term septicæmia, is a form of blood-poisoning believed to be due to the absorption in large quantities of the chemical products of putrefaction (*sepsine*, *putrescine*, *cadaverine*, &c.), derived from a septic or ill-drained wound. It is, therefore, a more severe form of septic traumatic fever, the difference being one of degree rather than of kind. Clinically, it is not always possible to distinguish it from septic traumatic fever on the one hand, and from septicæmia, or even pyæmia before metastatic abscesses are formed, on the other hand. It is probable, moreover, that sapræmia, septicæmia and pyæmia, though each may depend upon a different poison, often occur simultaneously in the same subject.

Cause.—For sapræmia to occur the septic poison must be absorbed in a sufficient quantity. Hence the cause may be said to be those conditions that lead to the production of the poison in large quantities and that favour its absorption into the blood. Amongst these may be mentioned—1. Extensive wounds recently made, inefficiently drained, and not kept aseptic. 2. Wounds of serous and synovial membranes. 3. Abscesses, cavities, and granulating wounds in which decomposing discharges are subjected to mechanical tension in consequence of the insufficiency of the external opening.

Pathology.—The poison, notwithstanding its virulence, is productive of very little in the way of *post-mortem* change which can be said to be characteristic. The parts on which its effects are more especially manifested are the blood, the gastro-intestinal canal, the nerve-centres, and the kidneys. Thus, the red blood-corpuscles undergo rapid disintegration, causing a staining of the tissues and vessels, and are found aggregated in little masses blocking the capillaries, and, probably, in consequence, producing the capillary hæmorrhages (*petechiæ*) which are found more or less over the whole body, and especially beneath the serous membranes. No micro-organisms are found in the blood if the examination is made immediately after death. The gastro-intestinal canal, the nerve-centres, and the viscera generally are congested; the congestion of the kidneys, by which organs the poison is principally eliminated, being especially marked. Decomposition occurs very rapidly after death.

The *Symptoms*, of which headache, vomiting, and delirium are the chief, usually come on about the second day after the infliction of the wound, and may be ushered in by a slight chill or even a severe rigor. The temperature suddenly rises to 103° or 104°; the skin becomes clammy, the tongue dry and furred; nausea or vomiting, and sometimes diarrhœa, set in; the patient becomes delirious, and if the dose of the poison has been large or its continuous absorption is not prevented, rapidly sinks into a state of collapse; the temperature falls possibly below normal, whilst the pulse continues rapid. The patient becomes unconscious, then comatose, and then dies. Where the dose absorbed has been less, the progress of the disease is less rapid, the patient becomes anæmic, and perhaps jaundiced, the urine albuminous, the spleen enlarged, the vomiting and diarrhœa continue, and death may occur from exhaustion.

The *Treatment* must be directed to the removal of the decomposing discharges from the wound or cavity. If this is promptly and effectually done, the disease will generally be arrested. Thus, wounds must be washed out with antiseptic lotions, serous cavities drained, joints laid freely open, and tension in abscesses removed by giving free vent to the pent-up and decomposing pus. The patient's strength in the meanwhile must be supported by fluid nourishment and the judicious administration of stimulants, and the subsequent anæmia combated by iron and quinine.

Local Infective Diseases.

Erysipelas is an infective, diffusely spreading inflammation, commonly affecting the skin or subcutaneous tissue, or both, less frequently the mucous membranes or submucous tissue, and still more rarely the serous membranes and the connective tissue in such situations as the pelvis, orbit, &c.

Cause.—Erysipelas depends upon the introduction of an infective micro-organism into the system; but for this to act it appears necessary that the vitality of the body should be lowered, and the tissues in consequence rendered less able to resist the injurious influence of the poison. The causes, therefore, may be divided into the predisposing and the exciting, the predisposing again into those that are general and those that are local.

The general predisposing causes are such as pertain either to (*a*) the state of nutrition of the body, or (*b*) its environment. (*a*). Among the conditions that predispose to the disease by inducing an impaired state of the tissues are—1, chronic alcoholism; 2, Bright's disease; 3, diabetes; 4, gout; 5, malignant disease; 6, insufficient food; 7, want of exercise combined with high living; 8, previous attacks of the disease. (*b*). Among the causes that pertain to the environment of the body are bad hygienic conditions of all kinds, as—1, imperfect ventilation; 2, defective drains; 3, accumulation of the products of decomposing organic matter; 4, overcrowding; 5, want of cleanliness; 6, a large number of suppurating wounds in a hospital; and 7, probably certain not altogether understood atmospheric influences. *The local predisposing cause* is the presence of a wound, scratch, or abrasion of the surface, and especially of a lacerated wound, or one in which the discharge is undergoing putrefaction.

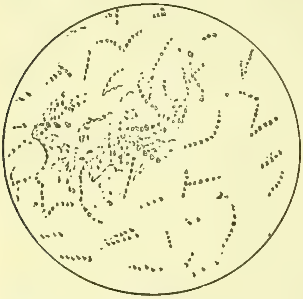
FIG. 38.—The *Streptococcus erysipelatosus* (Fehleisen).

The *exciting* cause is the introduction of some infective organism into the system. This poison is probably not the same in each form of the disease. In the cutaneous form it has been shown by the observations of Fehleisen to be a species of micrococcus, the *Streptococcus erysipelatosus* (Fig. 38). It had been known for some time that micrococci existed in the spreading margin of cutaneous erysipelas. Fehleisen cultivated some micrococci from this source, in some instances through thirty generations, *i.e.*, for upwards of six months, and then inoculated several patients, in all of whom, with the exception of one, who had just recovered from an attack of the disease, erysipelas, after an incubation period of from fifteen to sixty hours, was set up.* The contagion may be conveyed by the hands of the surgeon or nurse, and by instruments, sponges, &c.,

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* These inoculations were undertaken for the cure of lupus and malignant tumours, and in two instances apparently with success.

and probably by air and water. It is now supposed to enter the system in all cases through a wound. The so-called idiopathic erysipelas, in which there is ostensibly no wound, was thought to be an exception, but as this invariably occurs on exposed parts, as the face, it is now believed that the poison gains access through some slight crack or abrasion that has been overlooked. The streptococcus of erysipelas does not differ in morphology or cultural characters from the *Streptococcus pyogenes*, but opinions are still divided on the question of identity, though the weight of evidence is in favour of such identity.

Pathology.—The virus, when inoculated, multiplies in the tissues, and spreads by the lymphatic vessels and spaces. In the cutaneous form, according to Fehleisen and Metchnikoff, just beyond the spreading edge of redness where the skin is apparently normal, the lymphatics are crowded with micrococci; beneath the inflammatory blush the vessels are dilated and the tissues softened and infiltrated with leucocytes which are 'devouring' the micrococci. Still further inwards are large amœboid cells, derived from the connective tissue, in part absorbing the leucocytes and their contained micrococci, and in part preparing for the repair of the damaged tissues; whilst beneath the spot where the blush of redness has faded only dead micrococci are seen. The products of the micrococci, after passing through the lymphatic glands, which become swollen and tender, enter the system, producing the constitutional symptoms. When the cellular tissue is involved, suppuration generally occurs, and the vessels that run through it to the skin are destroyed, and the skin in consequence sloughs. The *post-mortem* appearance of the body is similar to that seen in other cases of septic poisoning. The organs are congested, and the blood is thin and fluid. The streptococci are not, as a rule, found in the blood; but the white corpuscles have been observed degenerated, and in some instances forming granular masses, plugging the capillaries of the lungs and brain.

VARIETIES.—Erysipelas may be divided into—1, the cutaneous or simple; 2, the cellulo-cutaneous or phlegmonous; and 3, the cellular or diffuse cellulitis.

1. CUTANEOUS OR SIMPLE ERYSIPELAS generally attacks the skin, less commonly the mucous membrane. It is a specific infective disease. The symptoms are *local* and *constitutional.*

Local signs.—There is a vivid blush of redness, usually, but not invariably, starting from a wound, and appearing either simultaneously with, or in some instances not till twenty-four or forty-eight hours after, the onset of the constitutional symptoms. The blush has a great tendency to spread, or to suddenly leave one part and attack another. The spreading edge is sharply defined and slightly raised above the surrounding skin, whilst the subsiding edge fades off into the healthy skin. The surface is usually at first vividly and uniformly red, œdematous, and shining, the redness fading momentarily on pressure, and later becoming of a dusky hue. The patient complains of a stiffness and stinging heat in the part. In very acute cases the cuticle is raised into blebs by the exudation of serous fluid beneath it, and the nearest lymphatic glands are generally tender and enlarged. Where the tissues are lax, as about the face or scrotum, there is much œdema, but there is little tendency to suppuration. When the inflammation subsides, there is usually some desquamation of the cuticle.

The *wound* itself, if one is present, takes on an unhealthy appearance; it ceases to heal, the edges swell, the granulations shrivel, and the surface becomes dry.

The constitutional symptoms generally begin with a chill or rigor. The temperature suddenly rises to 103° or 104°, or higher, but it does not fluctuate as in septicæmia and pyæmia. The pulse becomes rapid, and there is headache, loss of appetite, furred tongue and constipation, or sometimes diarrhœa.

Terminations.—The erysipelas as a rule gradually subsides, and the patient recovers; or it may spread over a large area, and the patient sink into a low typhoid state, and die of blood-poisoning (*septicæmia*), especially when the subject of kidney disease or other visceral trouble. When about the head and face it may spread to the larynx, and end fatally from œdematous laryngitis; or it may attack the membranes of the brain and set up meningitis. Relapses are common.

Treatment.—The bowels should be opened by a smart purge (Calomel, gr. v. c̄. jalap, gr. viii.), and subsequently perchloride of iron given in large doses (Tinct: ferri perchlor: m. xl, quartis horis). Slop diet is usually required at first, but as the constitutional symptoms generally assume a low type, the patient should not be too much depressed, as a stimulating plan of treatment will probably sooner or later be indicated. Thus, ammonia and bark, brandy-and-egg mixture, brandy, strong beef-tea, &c., are called for should the temperature run high, the pulse become soft, and the tongue dry and brown, or low muttering delirium set in. Locally, nothing answers better than dusting the part with equal quantities of oxide of zinc and starch powder, and enclosing it in a thick layer of cotton-wool. When there is an unhealthy wound, means should be taken to render this aseptic; but strong antiseptics, as carbolic acid, must be avoided, as they cause too much irritation. Should there be any collection of pus, or other pent-up discharge, it must of course be let out, and the part efficiently drained. When a patient is attacked with erysipelas in an hospital, he should be removed to an isolation ward, and the greatest care taken not to infect other patients. It was an old practice to draw a stick of nitrate of silver over the skin in front of the spreading edge of redness, and it was said that the erysipelas would not pass over this line. Since the teaching has been in vogue that the inflammatory reaction follows the spread of the micrococci, and is salutary in that the leucocytes destroy the micro-organisms, attempts have been made to set up inflammation in front of the encroaching microphytes by painting the skin with tincture of iodine. Cases in which the disease is said to have been thus arrested have been reported. More recently in severe cases an antitoxin (the anti-streptococcus serum) has been employed in the treatment of erysipelas.

2. CELLULO-CUTANEOUS, OR PHLEGMONOUS ERYSIPELAS, differs from the preceding variety, in that it involves the subcutaneous tissue as well as the skin. It is probably always associated with a scratch or wound, and nearly always terminates in suppuration of the subcutaneous tissue and sloughing of the skin, but it seldom penetrates beyond the deep fascia, unless this has been injured. It is most common in the intemperate, or those of broken-down constitution or the subject of visceral disease, and is especially frequent after a scalp wound.

Symptoms.—There is locally much more œdema and swelling than in the former variety, but the redness is less bright and not so sharply defined, and blebs or bullæ containing serum, which may be blood-stained, often form over the affected part. The pain, at first hot and tingling, soon becomes throbbing, and the swelling brawny, and, should suppuration occur, boggy in places; whilst the redness assumes first a dusky, then a purple, and then a mottled hue; finally, dark-coloured sloughs form, but no pointing occurs. If an incision is made into the tissues, they are at first found infiltrated with fluid, and later look like wet wash-leather from the breaking down of the cellular tissue into pus and sloughs. As the inflammation is more intense than in cutaneous erysipelas so are the constitutional symptoms, though similar, more severe. The fever, at first slight, assumes a typhoid character as suppuration sets in. The disease may *terminate* in resolution, but more frequently runs the course above described, and may end fatally from broncho-pneumonia, sapræmia, septicæmia, pyæmia, exhaustion, or hectic. It is most fatal when, as is so frequently the case, the patient is the subject of chronic kidney disease. Locally, it may lead to necrosis of bone, destruction of a joint, brawny thickening of the part, or much scarring.

Treatment.—This must be both constitutional and local. A purgative should be given at the onset, and the patient placed on slop diet, which should be exchanged, when suppuration occurs, for concentrated nourishment with bark, iron, and stimulants. Locally, lint or spongiopiline soaked in hot boracic lotion should be applied, and incisions made early before sloughing has had time to take place, *i.e.*, as soon as the parts become brawny. A number of small incisions made parallel to the long axis of the limb are preferable to one long one. They should extend through the skin into the inflamed cellular tissue, the hæmorrhage, which is often free, being readily stopped, if excessive, by plugging with iodoform or sal alembroth gauze, or like antiseptic material. Subsequently the wounds should be dressed antiseptically, well drained, and the sloughs removed from time to time as they form. At St. Bartholomew's Hospital a large charcoal poultice is with some a favourite form of dressing. Should diarrhœa set in it may be controlled by opium; but this drug must be given cautiously when there is kidney mischief. In bad cases, where much skin has been destroyed or a joint irreparably damaged, amputation may ultimately be required, but should not, as a rule, be done whilst the disease is in progress.

3. CELLULAR ERYSIPELAS, OR DIFFUSE CELLULITIS, is an acute, infective, and diffuse inflammation of the cellular tissue. It may occur in the subcutaneous or submucous tissues, in the inter-muscular planes, in the cellular tissue of the pelvis or orbit, in fact anywhere in the body where connective tissue exists. It may be due to various causes. Thus it may occur in the subcutaneous tissue after a scratch or puncture, particularly one inflicted in the *post-mortem* room; in the pelvic cellular tissue after parturition or the operation of lithotomy; and in the submucous tissue after an injury, as a sting of the throat by a wasp.

Symptoms.—The constitutional symptoms resemble those already given under the preceding varieties of erysipelas, and though they may vary in intensity they are generally grave and soon assume an asthenic type, and become those of sapræmia as the septic products are absorbed from the decomposing sloughs. The local symptoms vary according to the part attacked. When the subcutaneous tissue is affected they are similar to those of cellulo-cutaneous erysipelas, save that the skin is not at first involved, but is only slightly reddened or mottled: the parts, however, feel hard and brawny, and become boggy as suppuration occurs. Later, the skin, as the vessels which supply it are destroyed by the pressure of the inflammatory exudation in the subcutaneous tissue, loses its vitality, and rapidly becomes gangrenous and sloughs.

The *Treatment* is like that of cellulo-cutaneous erysipelas. Incisions should be made early, and stimulating treatment is generally required from the first.

HOSPITAL GANGRENE OR SLOUGHING PHAGEDÆNA is a rapidly spreading, infective inflammation accompanied by extensive sloughing and ulceration. It most commonly affects an open wound, but has been known to follow injuries where there has been no break in the skin. It is seldom seen at the present day, owing to improved hygiene, better hospital management, and the more scientific treatment of wounds. The virus, probably the pyogenic micrococci, may be conveyed to the wound by the air, the hands of the surgeon or nurse, instruments, sponges, &c. The micrococci (*streptococci* and *staphylococci*) are found in chains and masses as well as singly, both in the slough and in the inflamed tissues around. (See also *Phagedœnic Ulcers*, p. 34.)

Symptoms.—When an open wound is attacked, a pultaceous, ash-grey, adherent slough forms on the surface, and the sloughing rapidly spreads both deeply and widely. The edges of the wound are dusky-red, œdematous, sharp-cut and rapidly melt away as the gangrene proceeds. The discharge is thin and greenish or blood-stained, and exhales a horrible fœtor. Although a local infective disease, severe constitutional symptoms of blood-poisoning, rapidly assuming a typhoid character, are set up by the absorption of the septic products (*ptomaines*), and frequently terminate fatally in a few hours. No micro-organisms have been found in the blood.

Treatment.—The patient should be isolated, and where the disease occurs in military practice as an epidemic, the whole of the patients in the infected building should be removed to huts or tents. Stimulants, opium, and quinine should be given internally; whilst locally, the slough must be completely removed, the ulcerated surface thoroughly destroyed by strong nitric acid or chloride of zinc, and the wound sprinkled with iodoform and dressed antiseptically.

WOUND-DIPHTHERIA is seldom met with in this country. It is not caused except in very rare instances by the bacillus of diphtheria, but mostly by pyogenic micro-organisms. It is thought by some to be a mild form of hospital gangrene due to the ordinary microbes of suppuration, by others to be a distinct affection depending upon a specific form of micrococcus and the result of bad hygiene and want of cleanliness in the treatment of the wound. When a wound is so attacked, the surface, previously granulating, becomes covered with a greyish-white, opaque, tenacious membrane, similar to that of diphtheria. This membrane consists of granulation-cells and coagulated exudation in which are found micrococci in chains and colonies. The affection appears to be only very slightly contagious, and does not affect the system generally further than by the absorption of the septic products. The *treatment* consists in attention to the general hygiene, and dusting the wound with iodoform or rubbing it over with a stick of nitrate of silver.

MALIGNANT PUSTULE OR CHARBON is a specific infective disease due to inoculation with the *Bacillus anthracis*, obtained from animals suffering from splenic fever. It occurs most frequently in this country amongst those whose work brings them into contact with hides imported from countries in which splenic fever is common.

The bacillus may enter the system through a wound or abrasion of the skin, a pustule occurring at the point of inoculation. The disease may then remain localized, or the bacillus may enter the blood and there rapidly multiplying give rise to a true septicæmia or hæmic infection. At times the bacillus is absorbed directly into the blood through the alimentary or respiratory mucous membrane without any external manifestation, and sets up similar constitutional symptoms, the affection being then known as *Woolsorter's Disease.* (See a work on Medicine.)

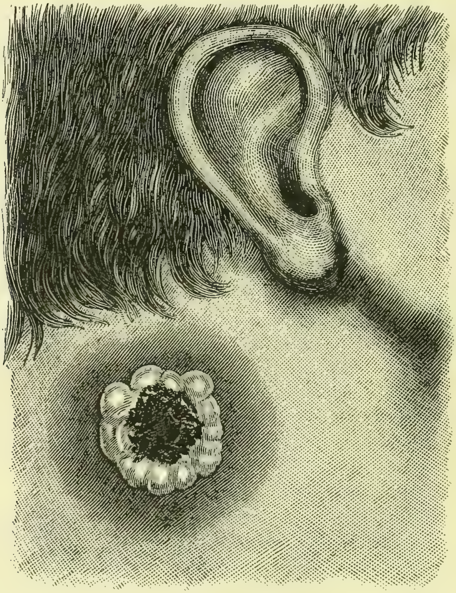


Fig. 39.—Malignant pustule. From a case under the care of the late Mr. Morrant Baker.

Symptoms.—A red itching pimple is first noticed, generally at the situation of a slight scratch or abrasion of the skin, on the face or some other exposed part. The pimple soon becomes converted into a vesicle, whilst the surrounding tissues become red and brawny. Gangrene occurs at the focus of inflammation, and around this a ring of secondary vesicles forms. Thus, when the so-called pustule is fully developed, it presents a very characteristic appearance (Fig. 39). In the centre there is a dry black slough, around this a ring of vesicles, and around this again an area of redness, brawny induration and much œdema. There is, however, but little pain and no suppuration. The neighbouring lymphatic glands may now become enlarged and tender; feverish symptoms rapidly assuming a typhoid type set in, and the patient dies of sudden syncope, exhaustion, or it may be of œdema of the glottis when the disease affects the neck. Should any doubt exist as to the nature of the disease, it will be cleared up by examining the contents of the vesicles for the bacillus.

The *Bacillus anthracis* (Fig. 40) is a straight rod-like body, varying from $\frac{1}{2000}$ to $\frac{1}{1400}$ of an inch in length. In artificial cultures it grows out into long threads made up of bacilli, the adjacent ends of which are sharply cut and slightly concave. It multiplies by fission and when in contact with oxygen by spores. It is readily killed by heat; but the spores resist both heat and drying, though they are destroyed by prolonged boiling, a 1 per cent. solution of corrosive sublimate and some other antiseptics. The bacillus is occasionally also found in the blood and in various tissues of the body in this disease.

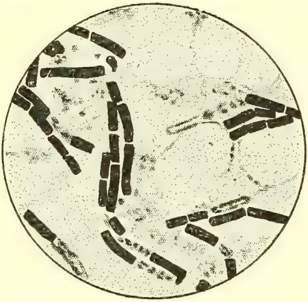


FIG. 40.—The anthrax bacillus. × 1,000. (After Sternberg.)

The *Treatment* consists in the free excision of the pustule. If this is done in time the patient usually recovers. Some merely scrape with a Volkmann's spoon; others cauterize the wound, after excision or scraping, with chloride of zinc or carbolic acid. Dusting with ipecacuanha powder is highly spoken of by some surgeons. When constitutional symptoms have developed, the strength must be supported by fluid nourishment and by stimulants when indicated. Sulphide of soda in ten-grain doses has been recommended on account of the beneficial effect it exercises in splenic fever in animals.

ACTINOMYCOSIS is an infective disease depending upon the presence in the tissues of a micro-organism, the actinomyces.

Cause.—The disease, which is prevalent in cattle, may in rare cases be transmitted to man from the diseased animal, as has been said to occur in cowmen, or it may be conveyed by cereals. A grain of barley has been found in several growths. A common site of inoculation is through a carious tooth, but the parasite may gain admission by the alimentary and respiratory tracts, or through a cutaneous wound.

Pathology.—The actinomyces, having entered the tissues, sets up a progressive inflammation leading to the formation of granulation-tissue, connective tissue and pus. The pus contains pale yellow, or sometimes white or brown grains, which are visible to the naked eye when the pus is spread out in a thin layer, the larger grains being about the size of a pin's head. These grains are seen, on careful microscopical examination, to be made up of fine threads of mycelium, with radiating club-shaped bodies at the periphery. The 'clubs' are at times absent and are believed by some to be involution forms and not essential to the disease (Fig. 41).

In cattle the disease affects chiefly the lower jaw, but it has also been met with in the upper jaw, the tongue, the respiratory and alimentary tracts, and in the subcutaneous and intermuscular tissues. It was formerly included under the names of osteosarcoma, wooden tongue, bone cancer, tubercle, &c.

Symptoms.—Actinomycosis may appear (1) in the skin (cutaneous), as for instance in the face (Fig. 42), breast, or abdominal wall; or (2) in the mucous membrane either of the mouth, pharynx, œsophagus, bladder, or intestinal tract; or (3) it may be visceral, when it is generally found in the liver or lung; (4) it has also in a few rare cases been found in the brain. When it occurs in the mouth it infiltrates the lower jaw as a rule, and it is then commonly met with about the socket of a carious tooth. A great deal of thickening occurs in the surrounding bone, and abscesses are formed in the neighbouring connective tissue. On the opening of the abscesses sinuses are left leading to the swelling, which is found to consist in part of tough fibrous tissue and in part of soft vascular granulation-tissue filling cavities in the bone. The escaping pus contains the grain-like masses of the fungus which are characteristic of the disease. When the disease occurs in bones other than the jaw, it gives rise to a growth with characters similar to those mentioned above. When it begins in the lung it may spread to the pleura and then extend widely in the chest walls. From the intestine it may invade the peritoneum and abdominal walls. In whatever situation it begins, if left alone, it steadily spreads until it kills

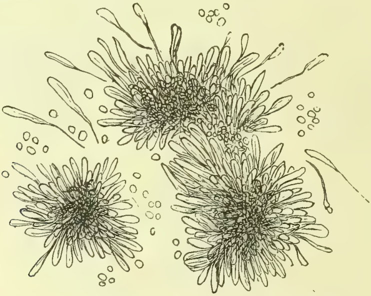


FIG. 41.—Actinomyces—the ray fungus.

either by exhaustion or by involving some vital organ. Metastases do not appear to occur in the lymphatic glands communicating with a primary focus of actinomycosis, but a pyæmic form of actinomycosis has been described.

Diagnosis.—The disease perhaps most resembles a gumma, tuberculous ulceration, or a fibro- or myxo-sarcoma attendedby profuse suppuration. The presence of the parasite in the pus will clear up any doubt as to the nature of the disease.

Treatment.—The most efficient treatment is the complete removal of the growth, whilst it is still local, by excision and scraping. In the lower jaw this has been attended with complete success. When the disease is too extensive to admit of removal, free drainage and antiseptics should be used as palliatives, and large doses of iodide of potassium given internally. This drug has been found of great value, both in man and in cattle, and should always be given, whether local treatment is or is not undertaken.

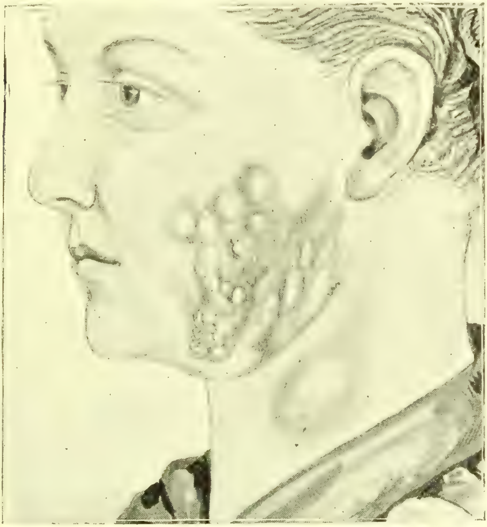


FIG. 42.—Actinomycosis of the face. (From a drawing of a patient. St. Bartholomew's Hospital Museum.)

General Infective Diseases.

SEPTICÆMIA OR SEPTIC INFECTION.—The term septicæmia is here estricted to the condition generally known as septic infection, using he term "septic" in its old sense; septic intoxication, which has itherto been included under the term septicæmia, has already been described under the head of sapræmia. Septicæmia, in this sense, is an infective disease due to inoculation with pyogenic (as distinguished from saprophytic or septic) micro-organisms, which multiply in the tissues or escape into the lymphatic or hæmic circulation.

It must be clearly understood that the term septicæmia is a clinical one given to well-known conditions easily recognised by their symptoms. Strictly speaking, that is, using the term in its pathological or bacteriological sense, *septicæmia* means *hæmic infection.* It is, therefore, necessary to remember that what is clinically a septicæmia includes two distinct pathological processes: a hæmic infection and a local infection accompanied by severe general intoxication. The infection which forms the starting-point of the disease may remain local, or it may for some reason or another become general, and yet the symptoms may be the same whatever condition prevails. As a matter of fact, micro-organisms are but rarely found in the blood in cases which on clinical grounds are diagnosed as septicæmia. The severity of the symptoms depends on the amount of toxins produced by the micro-organisms, and so far as this is concerned it matters little whether the infection remains local or becomes general.

Cause.—The essential cause of clinically so-called septicæmia is the introduction of a micro-organism into the tissues or into a wound. This organism almost always belongs to the group of pyogenic cocci. This living virus may be derived from the body of another patient who is suffering from or has died of the disease or some other pyogenic infection, such as erysipelas, and it may be conveyed by the hands of the surgeon or nurse, or by imperfectly-cleaned instruments, sponges, &c. The minutest quantity of the living contagium is sufficient. Although any one of the pyogenic cocci is capable of producing septicæmia, the one most to be feared is the *Streptococcus pyogenes;* it causes, far more frequently than other bacteria, spreading phlegmonous inflammations and grave forms of septicæmia. The importance and the frequency of streptococcus septicæmia accompanying tuberculosis, diphtheria, typhoid fever, scarlet fever, the puerperal state, erysipelas, cellulitis and traumatic infections are probably not even yet sufficiently appreciated by physicians and surgeons. Septicæmia produced by other pyogenic cocci under these circumstances, although it may be of equal severity and similar character, is less common. In view of the fearful pathogenic possibilities with which streptococci may be endowed, a surgeon cannot regard their presence in a wound or inflamed part with as little concern as he may the white, or even the yellow, staphylococcus. Streptococcus cases are in general more dangerous to other surgical patients in their proximity than staphylococcus cases, and are therefore more likely to require isolation (Welch).

Pathology.—Various pathological conditions may be associated with what on clinical grounds has been diagnosed as septicæmia. There may be (1) a local infection by pyogenic cocci, which may be spreading or phlegmonous. The cocci, being parasitic in nature and capable of growing in the living tissues, will spread beyond the seat of infection along the lymph-channels, and may thus produce fresh foci in and around the glands or wherever they find a resting-place. Naturally these cocci produce their poisonous substances; these are absorbed and lead to the aggregate of symptoms which constitutes septicæmia. (2) The cocci may find their way into the circulation, multiplying in the blood, so as to become demonstrable by ordinary methods of examination. They are then carried along the minutest vessels into all the tissues of the body, and the result is a general hæmic infection. In such cases they reach the heart by the venous circulation; they may infect the cardiac valves and produce a malignant endocarditis, which, as will be shown below, in its turn may lead to pyæmia. (3) The inflammatory process leads to plugging of the smaller vessels at the seat of infection; these thrombi are 'septic,' or rather infective, and particles may be carried by the veins into the right side of the heart and thence as emboli into the lung, where they would produce a pyæmic abscess (*pyæmia*). Doubtless pyogenic cocci frequently enter the blood-stream from the seat of infection in small numbers or waves. They often perish in the blood without doing harm, but they may lodge somewhere, as on one of the cardiac valves or on one of the serous membranes, multiply there, and produce a secondary inflammatory lesion, an infective endocarditis, or inflammation of a serous cavity. If it should be an infective endocarditis, micro-organisms will soon appear in the blood, *i.e.*, a hæmic infection will soon result. It will be seen then that in so-called septicæmia cocci will only be found in the blood, if there is a general hæmic infection, or an infective endocarditis, or if one should happen to examine the blood during one of the waves when the cocci are passing into the circulation.

The *post-mortem* appearances are similar to those of sapræmia. There is a like condition of congestion of the nerve-centres, gastro-intestinal tract and viscera, with petechiæ beneath the serous membranes, and staining of the vessels and tissues. Micro-organisms, both micrococci and bacilli, however, may be found in the blood under the conditions mentioned above. The serous cavities often contain blood-stained serum, and pleurisy and pneumonia may at times be present. The spleen is generally greatly congested and enlarged.

The *symptoms* are also similar to those of sapræmia; indeed, it is often impossible to differentiate between them. Septicæmia, however, may be suspected when there is evidence of infection from some source, or the wound is of such a size as to render it impossible for the amount of septic matter necessary to set up septic intoxication to be formed in it. It would, moreover, appear probable that the two diseases may at times coexist in the same subject. Septicæmia begins with a distinct rigor, which may be repeated, followed by a temperature of 103° to 104° or higher. The symptoms, the chief of which are headache, nausea, vomiting, delirium, and sometimes diarrhœa, may run the same rapid course as in sapræmia, the patient passing into a state of collapse; or they may be more chronic and less severe in degree though similar in kind, whilst leucocytosis and petechial eruptions of the skin, or bronchitis, pneumonia, pleurisy, or pericarditis may supervene.

Treatment.—Little can be done in the way of curative treatment beyond preventing the introduction of more poison by taking the same local means to disinfect the wound as were mentioned under sapræmia. The same good effects, however, must not be expected, as the poison once introduced multiplies indefinitely, and hence the disease is almost invariably fatal. Large doses of quinine or salicylic acid or sulphite of potash, however, may be given, whilst the strength should be supported by fluid nourishment and stimulants. Recently what appear to be promising results have been obtained with injections of an anti-streptococcus serum, which, if the lesion in question be due to the streptococcus, would hold out hope of success, and should certainly be tried early and in sufficient doses.

PYÆMIA is distinguished from septicæmia by the formation of secondary (*metastatic*) abscesses in various tissues and organs of the body. It received its name on the erroneous supposition that it was due to the entrance of pus into the blood, seeing that it generally originates in connection with a suppurating wound, and is later attended with purulent collections in various parts of the body. It is to be regarded as a special stage of septicæmia, and previous to the formation of the abscesses the two diseases are often clinically indistinguishable.

Cause.—The immediate cause is no doubt the entrance of a poison into the blood, and since pyogenic micrococci have been found in the wound, the thrombosed veins leading from the wound, in the blood, the tissues, and the metastatic abscesses, it is now held that these organisms are essential factors in the production of the condition known as pyæmia. There are no specific bacteria of either septicæmia or pyæmia. The same organisms are found in both. Pyæmia, however, is seldom developed except where the patient is exposed to unfavourable hygienic conditions, amongst which may be especially mentioned overcrowding in ill-ventilated and badly-drained hospitals, particularly where a large number of suppurating and foul wounds are congregated together in the same ward; whilst the general debility induced by insanitary dwellings, poor living, town life, and the abuse of alcohol, in that it lowers the resisting power of the tissues, further predisposes to the disease.

Pyæmia is generally developed in connection with a wound which has reached the stage of suppuration and has not been properly drained and kept aseptic. It is probable, therefore, that the septic products entering the system with the pyogenic micrococci further lower the resisting power of the tissues. The micrococci, most frequently streptococci, having gained admission to the wound, and probably having already produced a condition regarded as septicæmia, infect the thrombi, filling the veins leading from the wound, and are carried away with detached portions of the thrombi into the venous circulation. The emboli become lodged in the capillaries of the tissues and organs, and being infected with the pyogenic organisms from the wound, set up suppuration in the tissues around the vessels in which they lodge. In other instances it is believed that pyogenic micrococci may so multiply in the circulation or enter it in such masses that they are sufficient in themselves, without the presence of any clot, to plug the small vessels, and here in like manner cause secondary suppuration.

There appear to be, therefore, two chief elements at work in pyæmia, the pyogenic cocci giving rise to the disseminated suppurations, and the toxins developed in the wound and generated by the cocci themselves, poisoning the whole system. Pyæmia is especially common after wounds involving bone, owing to the liability of the large patulous veins of bone to become filled with purulent thrombi, portions of which are readily carried away by the blood-stream. Hence the frequency of pyæmia after injuries of the cranium involving the diploë, compound fractures, amputations, and excisions, when antiseptics and drainage are neglected. Again, the poison may be developed in retained portions of the placenta left after childbirth, and may then enter the blood by infecting the thrombi in the uterine veins. Or it may be formed in connection with operations on the genito-urinary tract, on account of the difficulty of keeping such wounds aseptic. Pyæmia, moreover, is especially frequent after infective osteomyelitis and infective periostitis, even before the suppurating cavity is opened and exposed to the outer air. It may also occur in connection with erysipelatous wounds, diffuse cellulitis, and hospital gangrene, and sometimes after gonorrhœa, ulceration of the intestines in typhoid fever and dysentery, and ulcerative endocarditis. Very occasionally pyæmia follows the most trivial operation or injury, as the subcutaneous division of a tendon or a portion of fascia. Here it is probably the result of the introduction of micro-organisms at the time of the operation. At times no local source of infection can be discovered; the disease is then spoken of as idiopathic pyæmia, and it is believed that the pyogenic micro-organisms gain admission, as in infective osteomyelitis, periostitis, and ulcerative endocarditis, through a mucous surface (see above).

Pathology.—The *post-mortem* appearances are similar to those in septicæmia, *plus* purulent collections in one or more situations, or disseminated through the body as multiple small abscesses. Thus, there is the same rapid tendency to putrefaction, disintegration of red blood-corpuscles, staining of the vessels and tissues, minute extravasations (*petechiæ*) beneath the serous membranes and in the skin, congestion of the viscera, enlargement of the spleen, and in many cases the presence of micro-organisms in the blood and various tissues and organs. The body is emaciated and the skin yellowish and earthy in appearance.

The purulent collections may be found in the serous cavities, in the viscera, in the joints, and indeed throughout the body generally. There may be one or more moderate-sized collections of pus; or an organ, as the lung, may be riddled by a number of small abscesses varying in size from a pea to a nut. The visceral abscesses are most common in the lungs, then in the liver, and next in the spleen, kidneys and brain. They are situated in the periphery of the organs, *i.e.*, in the situation of the terminal arterioles. Where, however, pyæmia follows a lesion of the rectum, the abscesses are generally found in the liver, since most of the blood from the rectum passes first through that organ. The pus is sweet, rarely fœtid, and may resemble ordinary pus, or it may be thin and watery. It always contains pyogenic micrococci. When there is a wound it is usually found unhealthy and surrounded by an inflammatory area; micrococci are present in it. The veins leading from the wound are usually filled with thrombi, which are generally, though not invariably, undergoing purulent softening, and then contain micrococci. Where the pyæmia has originated in infective osteomyelitis, infective periostitis, or in a wound involving bone, the veins in the medulla of the bone, and those leading from the bone, are usually also found filled with purulent thrombi. If the affected veins are followed towards the heart, the end of the thrombus will often be seen projecting into the blood-current in the larger vein at the spot where the smaller joins it (Fig. 43). Lastly, *coccus colonies*, *i.e.*, collections of micrococci, are found in the various tissues and organs.

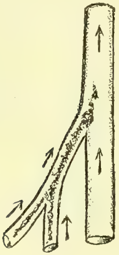


FIG. 43.—Thrombosed vein. The thrombus is seen projecting from the smaller into the larger vein.

A consideration of the above morbid appearances makes it appear probable that the metastatic abscesses may be produced in several ways: 1. Thrombosis of the veins leading from the wound is set up by one or more of the conditions that commonly produce thrombosis, such as suppuration around a vein, an abscess breaking into a vein, death of the part from which the vein runs, &c. The thrombus becomes impregnated with the septic products forming in the wound, and with the pyogenic micrococci introduced from without. The septic and infective changes extend up the thrombus; portions of the thrombus where it projects into a larger vein are detached by the force of the blood-stream in the larger vein (see Fig. 43), and are carried away in the blood, and become lodged in the capillaries of the lungs or, possibly, escaping through them, in the capillaries of other parts of the body. These emboli, being of a septic and infective nature, instead of leading to the changes which follow ordinary embolism, give rise to septic and infective inflammation terminating in suppuration and abscess (*primary embolic abscesses*). 2. Masses of micrococci which have gained entrance either directly through a wound, or indirectly through a mucous membrane, as in the case of infective periostitis, osteomyelitis, &c., are carried from the primary seat of disease by the lymphatics or blood-stream, and become lodged in the capillaries of the various tissues and organs. There blood-corpuscles aggregate around them, thus forming a thrombus, which softens and sets up infective inflammation and suppuration. 3. Portions of the softened thrombus in the lung-capillaries become detached, and are carried by the blood-stream to other parts of the body, where they in turn form emboli, which also set up similar infective inflammation and suppuration (*secondary embolic abscesses*). 4. The diffuse purulent collections in the serous and synovial cavities are thought as a rule to depend upon the poisoned condition of the blood and the presence of micrococci, not upon emboli. 5. In other instances, again, an infective or ulcerative endocarditis may be first produced in the manner previously described, and the vegetations on the cardiac or aortic valves give rise to septic emboli. Metastatic abscesses in the lungs are doubtless due to septic emboli carried there from the right side of the heart. In many cases secondary foci are not found elsewhere, and in others metastatic abscesses are found both in the pulmonary and systemic vascular areas. In the latter case the infection carriers must have been disseminated by the systemic circulation, either after an ulcerative endocarditis has first been produced, or, without this, by micro-organisms passing through or from the lungs into the left side of the heart in sufficiently large masses to plug the smallest vessels. 6. Again, organisms, as mentioned above, may enter the circulation from the seat of infection; they may then multiply in the blood, so that a general hæmic infection results; or they may for some reason or another be carried away without producing a general hæmic infection, but may lodge and grow in some internal or peripheral part, arrested there probably by some slight local lesion, and may here produce a suppurative metastasis. Unless there is an infective endocarditis, or a general hæmic infection, no organisms will be found free in the circulation. 7. A special form of pyæmia is hepatic or portal pyæmia. The liver does not, as a rule, participate in the general dissemination of suppurative foci, unless the seat of infection is situated in the portal vascular area, as, for instance, in the intestinal mucosa or the vermiform appendix.

The *symptoms* usually set in with a rigor, generally a severe one, during which the temperature rises to 103°, 104°, or even higher. Profuse sweating follows. The rigors are repeated from time to time. The temperature chart represents the same series of long up and down strokes characteristic of hectic fever, only differing in that the morning temperature in pyæmia seldom reaches normal. The pulse is quick; the tongue is red or glazed, and later, dry and brown; wasting rapidly sets in; the skin often assumes an earthy or jaundiced hue; the face is anxious, perhaps flushed, or pale; extravasations from the capillaries of the skin occur, producing petechiæ; and other eruptions, though less common, as patches of erythema or purpura, may appear from time to time, with aphthæ or ulceration of the fauces. The breath and the exhalations of the body have a peculiar sweet odour, and albumen may be found in the urine. At about the end of a week metastatic abscesses form in various parts, as the lungs, liver and joints; or diffuse suppuration may be set up in the serous cavities, and signs of pericarditis, pleurisy, or peritonitis ensue. Diarrhœa sets in, then delirium, and the patient dies exhausted usually during the second week. In the meanwhile, the wound, if one exists, is generally foul and suppurating, though later it may become dry and cease to form pus: in some chronic cases, which are rare, however, the wound may heal. The *prognosis* is extremely unfavourable; acute cases are always fatal, each rigor making the chance of recovery more hopeless. At times, however, the disease may run a chronic course (*chronic pyæmia*), differing from the acute in degree rather than in kind. Thus the rigors are less frequent or none may occur. The viscera, as a rule, are not affected, and the abscesses show a special predilection for the joints. The patient may die after some weeks, or may linger for some months, or very slowly recover after one or more relapses, with probably stiffness of one or more joints. Or he may subsequently die of phthisis, albuminuria, or lardaceous disease.

Treatment.—Little or nothing can be done in the way of treatment in acute cases, when once the pyæmic process is fully established, beyond supporting the strength by fluid nourishment and stimulants, opening abscesses as they are formed, and placing the patient under the most favourable hygienic conditions possible. Measures should, of course, be taken to drain the wound and render it aseptic if this has been neglected. Quinine in large doses is generally advised, but little must be expected from it. There is reason to hope, however, that in the early stages, when the disease is due to the streptococcus, the copious use of the anti-streptococcus serum will be of service. In infective osteomyelitis and periostitis amputation through the joint above the affected bone should be done if pyæmia appears imminent but has not fully declared itself. As the pyæmia here is generally due to the *Staphylococcus pyogenes aureus*, an anti-streptococcus serum is not of service. In chronic cases, when convalescence has ensued, a sea-voyage or residence at Aix-la-Chapelle or other suitable spa may be of benefit.

GLANDERS is a specific infective disease common amongst horses, and occasionally communicated to man by inoculation through a wound or the unbroken mucous membrane. The virus is believed to be a specific form of micro-organism, the *Bacillus mallei*, since this bacillus after several cultivations retains the power of reproducing the disease in the horse. The disease may run an acute or chronic course. It is nearly always acute in man and chronic in the horse. *The acute form* is characterized: (1) by a thin serous discharge, rapidly becoming foul, purulent, and sanious, from the nasal mucous membrane, with enlargement of the submaxillary glands; (2) by a pustular eruption, resembling that of small-pox, on the skin and mucous membrane of the respiratory and digestive tract; and (3) by the formation of circumscribed nodules in the lymphatics of the subcutaneous and muscular tissue, which usually soon break down into abscesses and foul ulcers. These signs are ushered in and accompanied by fever, which rapidly assumes a typhoid type, and is sometimes preceded by a rigor. Symptoms of pneumonia or pleurisy, or vomiting and diarrhœa ensue, according as the respiratory or alimentary tract is chiefly affected, and death usually takes place within a week from sapræmia, septicæmia, or pyæmia. In the *chronic* form the constitutional symptoms are less severe, and the patient may linger for months, or even recover.

In the horse the disease is spoken of by veterinary surgeons as "*farcy*" when the lymphatic vessels and glands are principally affected, the swellings opposite the valves in the lymphatics forming the so-called "*farcy-buds;*" and as *glanders*, when the disease falls chiefly upon the nasal mucous membrane. In man the two processes generally occur together as above described.

Treatment.—Beyond supporting the patient's strength with concentrated fluid nourishment, opening abscesses as they occur, dressing the ulcers antiseptically, and syringing out the nasal chambers with antiseptic lotions, little or nothing can be done, as no treatment appears to have been hitherto of any avail. It has been recently shown that a chemical substance (*mallein*) present in the artificial cultures of the glanders bacilli produces no reaction when injected into the tissues of healthy animals: but when injected into the tissues of animals affected with glanders a decided rise of temperature takes place. A means of making an early diagnosis is thus afforded, and by its use the disease might probably be stamped out of infected stables.

Hydrophobia is a specific infective disease, always propagated by inoculation, and probably due to a specific micro-organism. It has received its name from the prominent symptoms which the pharyngeal spasms produce. It is called rabies in dogs because no fear of water is shown, and because in them there may be great excitement. The disease is generally received by man from the dog, occasionally from the wolf, and more rarely from the cat or fox, and by these animals it may be given to horses, deer, &c. The inoculation is generally through a bite by which the saliva containing the virus reaches the lymphatics. At times it has occurred through a scratch which has been only licked by the affected animal, and once through making a *post-mortem* examination on a subject who had died of the disease. Of all persons bitten by rabid animals, about 15 per cent. only suffer from the disease, a fact which probably in chief part depends upon the saliva being wiped off the teeth as they pass through the clothes. The most dangerous wounds are those on the face and hands, and on the bare legs of children, the average mortality of bites on the face being as high as 60 to 80 per cent. Multiple and lacerated wounds are naturally most to be feared, as inoculation in them is more likely to take place. Also the nearer the bite is to the central nervous system, the more easily and rapidly does the poison reach the brain and begin to take effect. Indeed the only certain method of producing the disease in animals is by inoculation under the dura mater. It was the discovery of this fact which led M. Pasteur to make his investigations.

The *average period of incubation* varies from two weeks to six months. Although it is said that the incubation period has been as short as two days, and as long as twenty years, two weeks to two years may practically be given as its limits. There are no symptoms during this period. The vesicles or lyssæ said to occur under the tongue from the third to the ninth day after the bite do not appear to be a constant phenomenon. The virus has no influence on the healing of the wound, the bite of a mad dog healing like other wounds, either by first intention, or, if the tissues are badly lacerated, slowly and painfully.

Seeing therefore that there are no symptoms during the incubation period, and that in the early stages of rabies there are no naked-eye *post-mortem* signs, the only way of ascertaining if the bite is that of a mad dog is to watch the animal. If the dog is killed at once the patient will suffer much mental anxiety. He must wait for three weeks before the point can be determined by inoculation experiments on rabbits, or he may undergo Pasteur's treatment unnecessarily. Moreover, to wait three weeks may be too late for wounds of the face. Every suspected dog, therefore, should be confined in a strong cage. If mad he will show advancing symptoms, and die in three or four days. It is important, therefore, to recognize the symptoms of rabies in the dog.

Symptoms of rabies.—The earliest symptoms are restlessness, dulness, and a tendency to shun the light. The dog often roves far and wide, and has a morbid appetite for pieces of stick, hay, stones, &c. In the next stage he may rush wildly about, biting other dogs, inanimate objects, or men, frequently those to whom he has been previously attached. The appetite is lost; there is a desire to drink, and the muzzle is put into the water, but none is taken. Finally he becomes paralyzed, the lower jaw begins to drop, the bark changes to a characteristic hoarse howl from pharyngeal paralysis; next the limbs fail, and finally the muscles of respiration. Sometimes, however, advancing paralysis is the only symptom, the power of barking being then lost. This form of the disease is called *dumb rabies.*

Post-mortem signs of rabies.—The stomach contains hay, sticks, stones, &c., and its mucous membrane is congested and scattered over with small hæmorrhages. The trachea is congested and may also be dotted over with small hæmorrhages. The nervous system, especially the cord and medulla, show signs of acute myelitis. This begins with an exudation of leucocytes into the sheaths of dilated vessels, then hæmorrhage, and finally softening. If a portion of the medulla or cord is required for inoculating purposes, a piece should be placed at once in a 20 p.c. solution of glycerine and kept there for three or four days to kill septic micro-organisms; an emulsion is then made and a drop or two injected under the dura mater of a rabbit, which will die in from eighteen to twenty-one days, showing first excitement and then paralysis of the hinder limbs, extending later to the fore-limbs and head.

Pathology of hydrophobia.—The principal *post-mortem* changes have been found in the medulla, especially about the region of the glosso-pharyngeal, pneumo-gastric and hypo-glossal nuclei, and in the cerebral cortex. They consist in the infiltration of the perivascular sheaths with leucocytes, thrombosis of the medium-sized vessels, small hæmorrhages, and degeneration of the nerve cells; in short, as in animals, of an acute myelitis. The theory now generally held with regard to the pathology of the disease is that the poison, after remaining for a variable time dormant in the wound, multiplies or matures; and then that either it or its products slowly enter the blood and set up a specific inflammation in the medulla and cerebral cortex, whereby their power of resistance to reflex irritation is diminished or lost. Hence the occurrence of the spasms on the slightest provocation. Finally, that should the patient not succumb to spasm of the glottis or muscles of respiration, the affected nerve-centres become exhausted and no longer respond at all to the reflexes necessary to carry on life, and the heart's action in consequence ceases. The nature of the poison is not known, though the belief is gaining ground that the disease depends in some way upon a micro-organism, since rod-like bodies have been discovered in connection with the hæmorrhagic lesions in the cerebral cortex, and a micro-organism has been isolated by inoculating fowls with the virus taken from rabid animals.

Symptoms of hydrophobia.—At first there may be pricking pain, perhaps some redness and tumidity, at the site of the wound, which has generally long since healed. The patient, if an adult, has often much mental anxiety, and with the onset of the symptoms may become melancholic. As the disease becomes fully developed the symptoms point to disturbance in the medulla, especially about the centres for deglutition and respiration. Thus there is increasing difficulty in swallowing in consequence of pharyngeal spasm, and a peculiar click in respiration in consequence of spasm of the diaphragm. The pharyngeal spasms are at first only excited by attempts to swallow, but subsequently the sight of water and the sound of its trickling from one vessel to another, a blast of cold air, or a sudden light, is sufficient to set them up. Swallowing is now quite impossible, and viscid saliva is forcibly hawked up and expectorated about. The spasms, which begin in the pharynx, extend to the muscles of respiration and then become general; the pain is agonizing and the patient may have hallucinations or violent delirium, but often remains sensible of his dreadful condition to the end. Paralysis finally ensues, and death usually occurs from involvement of the respiratory muscles. The spasms sometimes diminish as the paralysis advances, and the patient may sink into a delusive calm, during which the power of swallowing may be regained. Sometimes the chief symptom throughout is advancing paralysis. Such cases resemble dumb rabies of dogs.

Death may be due in the earlier stages to spasm of the glottis or muscles of respiration; later to paralysis of the muscles of respiration or to exhaustion.

Diagnosis.—The *intermittent* character of the spasms (*clonic spasms*), the hallucinations, and the escape of viscid saliva from the mouth, will generally serve to distinguish hydrophobia from tetanus following the bite of a dog, and from false or hysterical hydrophobia. In the latter case, too, the convulsions will cease if the patient is put under chloroform.

The prognosis when the disease has once developed is hopeless. There is no authentic case of recovery from hydrophobia.

The treatment may be divided into the preventive and palliative. *Preventive treatment.*—If the patient is seen immediately after the bite, we should endeavour to remove the poison from the wound, or else destroy it. This may be attempted by suction, a procedure which appears to be quite safe provided there is no crack or abrasion about the lips or tongue; or if at hand, a cupping-glass may be applied. The parts should afterwards be excised or thoroughly cauterized, the best caustics being nitric acid, nitrate of silver, caustic potash, and pure carbolic acid. It has been advised that if the wound has already healed when the patient is seen the cicatrix should be cut out; but it is more than questionable if this procedure is of any value, especially as it appears that if inoculation by M. Pasteur's method is resorted to before symptoms come on, the disease may be effectually prevented from developing.

Pasteur's treatment.—This consists in obtaining a virus of fixed strength and then attenuating it so that it can be safely inoculated. To obtain the fixed virus the disease is transmitted through a series of rabbits, the period of incubation becoming less and less as the virus increases in intensity, till, after passing through upwards of eighty rabbits, the period of inoculation is found to be constant and the virus of maximum intensity. A rabbit inoculated with this fixed virus always develops symptoms on the seventh day and dies on the tenth. To attenuate the virus a portion of spinal cord of a rabbit inoculated with the fixed virus is suspended in a sterilized bottle over caustic potash. As the cord dries the virus becomes less virulent, so that after two days' drying a rabbit inoculated with it dies in from 11 to 17 days; after 7 days' drying from 23 to 29 days; after 11 days' drying from 30 to 35 days; until after 12, 13, or 14 days' drying, its virulence is completely lost. An emulsion is made of 0·5 centigrams of spinal cord in 2 cubic centimetres of sterilized beef-tea, and a drop or two is subcutaneously injected under the skin of the abdomen or flank. The cords are used in an ascending series from the fourteenth or fifteenth day of drying upwards, until on the ninth day of treatment a cord which has been dried for only three days is used. The treatment is continued for 16 days. The above is known as the *Simple method*. For face-bites a more rapid method has been found necessary to prevent the disease. In this, which is called the *Intensive method*, a cord of only three days' drying is used on the sixth day, and the treatment is continued with two days' intermission until the twentieth day. This method, however, appears to be somewhat dangerous, a few patients so treated having died with symptoms of the paralytic form of the disease similar to that induced in animals by inoculation.

Palliative treatment.—When hydrophobia has supervened, all that can be done is to relieve symptoms. Thus the patient should be placed in a darkened room, and every source of irritation that may cause spasm avoided. Opium and morphia should also be given for the same purpose. Chloral, chloroform, eserine, pilocarpine, curare, and many other drugs have been given; but all are useless, and some, as chloroform and curare, are not unattended with danger.

TETANUS is a disease in which the voluntary muscles are thrown from time to time into a state of intense spasm, whilst they remain in the intervals in a condition of constant contraction (*tonic spasm*).

Cause.—Tetanus was formerly attributed to a lesion of the peripheral nerves; but it is now known to be a toxic infection, depending upon a specific virus generated by the growth of the tetanus bacillus. It is especially prevalent in hot climates, and amongst the negro races; it occurs more often in men than in women, and in military than in civil practice. It is especially common after lacerated and punctured wounds and burns; but it has been met with after every kind of wound, from a mere scratch, or the ligature of a pile or the umbilical cord, to amputation of the thigh or other capital operation. Tetanus, however, has been more often observed when the wound, whatever its cause and character, is in a septic condition. Exposure to cold, damp, and sudden changes of temperature were believed to influence its production, and where tetanus occurs, as it sometimes does, without an apparent wound, were regarded by some as the essential cause. It would appear, however, that such conditions merely act as depressing agents, and that the micro-organism in these cases gains admission through a scratch or abrasion which has been overlooked.

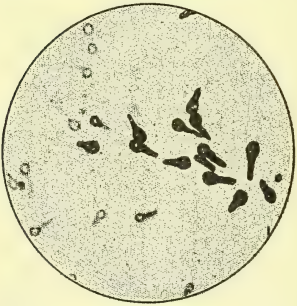


FIG. 44.—The tetanus bacillus. ×1,000. (After Sternberg.)

Tetanus is inoculable from animal to animal, and probably from animals to man, since a veterinary surgeon has lately died of tetanus after making a *post-mortem* examination of a horse dead of the disease.

Pathology.—But little is discoverable on *post-mortem* examination. At times the nerves leading from the wound have been found congested, at other times unaltered in appearance. Hyperæmia of the medulla and cord, exudation in and degeneration of the grey matter, and hæmorrhages in the white columns, have been noted in some cases; whilst in others nothing abnormal in the nerve-centres has been discovered. The *modern view* of the pathology of tetanus is that it is a toxic infection due to a specific virus which affects the medulla and cord in a way similar to strychnine. The virus (*tetanin*, *tetano-toxin*) is a chemical compound, but according to the researches of Vaillard, Vincent, Brieger and others, is neither an alkaloid nor an albumose, but is allied to snake-poison or an exzyme. It is generated in a wound by the growth of the tetanus bacillus. It is only within recent years that an absolutely pure culture of the bacillus has been obtained by Kitasato, but since then its cultivation has become easy (Fig. 44). The bacillus occurs as long delicate threads with slightly rounded ends. When sporing, these threads break up into short rods which usually develop a spore at one end, giving them a drumstick shape. It is anærobic, and hence rapidly loses its virulence on exposure to air. Its special habitat would appear to be ordinary earth, thus serving to explain the frequency of tetanus in the wounded who have been allowed to lie on the ground after battles. It has been found in the surroundings of horses, the floor of stables, and in soil taken from beneath the floor of hospital wards in which cases of tetanus have occurred. The bacillus only exists in the soil or in the wound; not in the blood or nervous system. The bacilli proliferate or grow only at and around the site of inoculation, and do not spread into the blood or invade the organs; again, they do not survive long in the wound, for a few days after infection they cannot be discovered either microscopically or by artificial cultivation. The bacilli manufacture a toxin, which is absorbed, and passing along the perineural lymphatics reaches the spinal cord, and acting on the motor cells produces the characteristic spasms. Cutting out the nerves of a limb of an animal which has been inoculated in that limb, delays the onset of tetanus considerably, and thus a former method of treatment, the excision of nerves, finds some pathological support. Experimentally all the symptoms of tetanus can be produced by injections of the germ-free toxins of tetanus cultures. The toxin does not cause spasms immediately after inoculation, and with small doses it may require days before any appear. In experimental animals the spasms become apparent first in the muscles nearest the seat of inoculation. It is curious that animals may be carefully inoculated with large doses of toxin-free spores or bacilli without contracting tetanus, while a few such spores or bacilli inoculated together with other organisms, such as the *Bacillus coli communis* or pyogenic cocci, will readily produce tetanus. Clinically, also, tetanus complicated by septic or suppurating wounds is severer than tetanus associated with a slight or clean wound. The tetanus toxin can frequently be found in the blood both during life and after death, and is not eliminated to any appreciable degree by the urine.

The *symptoms* usually begin by a feeling of stiffness in the muscles of the neck; the patient complains that he is unable to open his mouth widely (*trismus*), and that his throat feels sore on swallowing. On examination, the muscles of the neck, the masseters, and perhaps the abdominal muscles, are found hard and rigid, and the face presents a characteristic expression from the angles of the mouth being drawn slightly upwards by the contraction of the facial muscles. Later, other of the voluntary muscles, especially those of respiration, become affected, and distinct spasms, attended with severe pain and varying in duration, occur from time to time. The spasms are induced by the slightest irritation, a breath of air, the least noise, the merest touch, and the remissions become shorter, or only partial, as the disease is fully established. During the spasms the face assumes an expression of intense anguish (*risus sardonicus*), the respirations and pulse are quickened, and the body is variously contorted. Thus, when the spinal muscles are chiefly affected the back becomes arched, so that in severe cases the patient rests only on his head and heels (*opisthotonos*); more rarely the body is bent forward, being rolled up as it were like a ball (*emprosthotonos*); whilst still more rarely it may be drawn to one or other side (*pleurosthotonos*). The skin is bathed in perspiration, the urine concentrated and high-coloured, and the bowels obstinately confined. The temperature may remain normal, or be but slightly raised; though sometimes shortly before death it runs very high, and has been known to register 112° Fahr. The patient is unable to sleep, but the intellect continues clear to the end. Death may occur from spasm of the glottis, spasm of the respiratory muscles, or from exhaustion or syncope. Recovery hardly ever takes place when the symptoms are acute, but if the patient survive till the twelfth day the prognosis is more favourable, and becomes more and more so every day.

Varieties.—Clinically several forms of tetanus may be recognized. In *traumatic* tetanus a wound is always found, which may be no more than a mere scratch or puncture, or a severe suppurating or septic lesion. In *idiopathic* or *rheumatic* tetanus no wound is visible, but it is erroneous to assume that infection has taken place without a breach of surface. *Tetanus neonatorum* occurs in new-born infants, the umbilical cord being the seat of infection; *tetanus puerperalis* in lying-in women, the bacilli being carried generally through negligence to the raw uterine surface. *Cephalic tetanus* follows an injury of the face or head, and is characterized by the presence of facial paralysis. From a prognostic point of view it is important to distinguish between *acute* and *chronic* forms of tetanus. A case is acute if (*a*) the incubation is short, under seven days, and (*b*) the onset of *general* spasms quick, twenty-four to forty-eight hours; it is chronic if (*a*) the incubation is prolonged, eight to fourteen days, and (*b*) the onset of *general* spasms delayed or absent. The general mortality of tetanus is about 45 to 50 per cent., that of acute cases being about 80 to 90 per cent., and of chronic cases 15 to 20 per cent.

Diagnosis.—From strychnine poisoning and hydrophobia, tetanus is distinguished by the spasms being of a tonic instead of a clonic character, and further from hydrophobia by the absence of hallucinations and the discharge of viscid saliva, signs which are characteristic of that affection.

Treatment.—Hitherto the treatment has consisted in attempting to tide the patient over the first few days in the hope that the affection might become less acute and gradually wear itself out. Thus little or nothing could be done beyond supporting the strength with fluid nourishment, administered by the rectum if the patient is unable to swallow, and preventing the spasms as much as possible by the most absolute quiet, the avoidance of all sources of irritation, the employment of such sedatives as chloral or opium, and relieving the constipation by purgatives and enemata. Curaræ, Indian hemp, Calabar bean, eserine, and numerous other drugs internally, and subcutaneous injections of carbolic acid ($\frac{1}{6}$th of a grain), paraldehyde, pilocarpine and urethane, have all had their advocates, and cases have been reported in which success was attributed to their use. The treatment of tetanus, however, has through the recent researches of Behring, Kitasato, Tizzoni, Cattani, Roux, Vaillard and others, been placed on a different footing, and the injection of the tetanus antitoxin, with the excision of the wound, although success has not yet been met with in any case that might not possibly have otherwise recovered, may be looked upon as the only rational treatment. It has been found by these observers that the blood serum of animals rendered highly immune to tetanus by previous injections of the tetanus-poison (*tetano-toxin*) taken from artificial cultures of the bacilli, possesses the power when injected into another animal of destroying the toxic properties of the tetano-toxin, or of conferring immunity on the animal even though twenty or thirty times the amount sufficient to kill be injected. In an ordinary case of tetanus, however, the injection of the antitoxin is not sufficient, in that fresh doses of the poison are continually being generated by the bacilli in the wound and absorbed into the system. On the earliest signs of tetanus, therefore, the wound should be freely excised or amputation performed before the antitoxin treatment is begun. The antitoxin should be injected subcutaneously into any part of the body, preferably the abdominal walls or the inner part of the thigh. The dose will depend upon the severity of the case, the period of the disease at which the treatment is begun, and the quality of the antitoxin used. It must be large if the case is severe and if treatment has been delayed for some days after the symptoms have come on; but results with the antitoxin as at present manufactured have not been good. Moreover, it must be remembered that the antitoxin is an immunizing and not a curative agent, hence it should be employed on the earliest appearance of the disease. In preparing and injecting the antitoxin, care must be taken that it does not come into contact with chemical antiseptics or heat, since both impair its action.

SECTION III.

INJURIES OF SPECIAL TISSUES.

INJURIES OF BONES.

FRACTURES.—A fracture may be defined as a sudden and forcible solution of continuity in a bone.

The *Causes* of fracture are predisposing and exciting. 1. The *predisposing causes* may be enumerated as senile atrophy, atrophy from pressure or disuse, fatty degeneration, rickets, fragilitas ossium, osteomalacia, osteomalacia carcinomatosa, locomotor ataxy, tubercle, syphilitic gummata, caries and necrosis, hydatid cysts, and malignant growths; in brief, any condition rendering the bone unusually fragile, to which may be added the male sex as more frequently exposing to violence. The *exciting causes* are either external violence or muscular action. (*a*) *External violence* may be direct or indirect. In fracture from *direct* violence the bone is broken at the spot where the violence is applied. Such fractures are usually attended with more serious consequences than fractures from indirect violence, since the soft parts are, as a rule, much injured, and the fragments comminuted or fissured, and, perhaps, driven into important organs, as the lung in fracture of the ribs, or the brain in fracture of the cranium, &c. In *indirect* violence the fracture occurs at a distance from the spot where the violence is applied, as, for instance, a fracture of the clavicle from a fall on the arm. The bone usually breaks at its weakest spot, and the fracture may be rendered compound from the fragments, which are often sharp and irregular, being driven through the soft parts. Fracture from indirect violence is most common in the bones of the extremities, and the base of the skull. (*b*) *Muscular action*, except in the case of the patella, is not a common cause of fracture. When the long bones are broken in this way, they are usually the seat of some of the affections mentioned above as predisposing causes. When a bone infiltrated with a malignant growth, or softened by osteomalacia, breaks from very slight violence, the fracture is said to occur *spontaneously*.

Varieties of fracture.—A fracture is said to be *simple* when the skin covering it is not broken; *compound* when a wound through the skin and soft parts leads down to the seat of the fracture. Whether simple or compound, fractures are further spoken of:—1. According to their extent, as:—*complete*, when the bone is broken quite across; *incomplete* or *greenstick*, when partially broken and partially bent; *comminuted*, when broken into several pieces; and *multiple*, when two or more distinct fractures occur in the same bone, or in different bones. 2. According to the condition of the fragments, as:—*impacted*, when one fragment is driven into another; *fissured*, when there is a mere crack through the bone without displacement; *depressed*, when one fragment is pressed in below the surface, as in some fractures of the cranium; *punctured*, when there is a small perforation with driving inwards of the fragments; and *splintered*, when only a fragment of bone is chipped off. 3. According to the line of fracture, as:—*transverse*, *oblique*, *spiral*, *longitudinal*, Y- or T-*shaped*, and *stellate*, terms which sufficiently explain themselves. A fracture, moreover, is said to be *complicated* when associated with other injuries, as rupture of the main artery of the limb, implication of a large joint, &c.

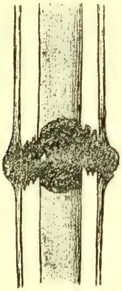
Displacement of the fragments, especially in the bones of the limbs, commonly occurs, except the fracture is transverse, when, as in the case of the tibia, there may be little or none. The causes of the displacement may be enumerated as:—1. The weight of the limb acting on the lower fragment; 2. Muscular contraction; and 3. The violence producing the fracture. The amount of displacement will depend in part on the direction of the line of fracture, and in part on whether the periosteum is or is not torn. Thus the displacement is usually considerable when the fracture is oblique, insignificant when transverse, especially if the periosteum is intact. The displacement is spoken of as *angular*, *lateral*, *longitudinal*, and *rotatory*, according to the direction which the fragments bear to each other.

Signs.—Before examining for fracture, an accurate history of the accident should, if possible, be obtained, since much light may thus be thrown on the nature of the injury. The clothes should then be carefully removed, and the parts handled tenderly, lest a simple fracture be converted into a compound by a sharp fragment being driven through the skin. Thus, in the case of the leg, the boot should be cut off, the trousers ripped up the seam, and the stocking split with scissors. The injured side should always be compared with the sound side. The general signs of fracture are:—1. Alteration in the shape of the part; 2. Swelling; 3. Impairment or loss of function; 4. Preternatural mobility; 5. Shortening; 6. Pain; 7. Crepitus; 8. The sensation of a sudden snap or giving way of the bone experienced by the patient. No one of the above signs alone, except *crepitus*, is absolutely diagnostic of fracture; and crepitus itself, when the fragments are impacted and when the fracture is of the greenstick variety, may be absent, or may be simulated by joint-crepitus, effusion into the sheaths of tendons, emphysema, and by the grating of osteophytes in chronic osteoarthritis. True crepitus, however, having been once felt, can hardly afterwards be mistaken; it is readily distinguished from false crepitus by its harsher and more grating character. The *shortening* may be natural or due to some previous injury or disease, as a former fracture, osteo-arthritis, &c.; shortening also occurs in dislocation. *Increased mobility* may not be present, as when a fracture is firmly impacted. *Pain* may, of course, occur from causes other than fracture; it may often be elicited in fracture when crepitus cannot be obtained. *Swelling, loss of function and alteration in the shape* of the part may be present in other injuries, but are useful signs in some forms of fracture. Too much weight, it need hardly be said, should not be given to the patient's *sensations*, as a snap or feeling of the bone giving way may occur in rupture of a tendon or ligament.

The *Diagnosis* is often difficult, especially:—1. When the fracture is near, or extends into, a joint, owing to effusion of blood or synovial fluid into the joint-cavity. 2. When there is great extravasation of blood, or later, effusion of inflammatory products about the fragments. 3. When the fracture is transverse, and there is no displacement, especially if the fragments are held in position by a companion bone, as the fibula in fracture of the tibia. 4. When the fracture is subperiosteal. In the cranium, a simple uncomplicated fissured fracture cannot be diagnosed. In doubtful cases of fracture much aid may often be obtained by means of the x rays.

How to obtain crepitus.—Grasp the limb firmly above and below the suspected fracture, and when there is shortening, make extension to bring the rough surfaces into contact. Then gently attempt to move the lower on the upper fragment. Having once assured yourself that crepitus is present, desist from your manipulations, as they not only give the patient pain, but injure the soft parts. In some cases, as in fracture of the neck of the femur, where the nature of the injury from the presence of other signs is quite obvious, crepitus should not be sought lest an impacted fracture be rendered non-impacted and afterwards remain ununited, or the periosteum uniting the fragments be torn, and a like result ensue.

The method of union is similar to that which occurs in the healing of a wound of the soft parts by the first intention. Blood is at first extravasated between and around the fragments (Fig. 45). Then quickly follows a simple traumatic inflammation; the periosteum and adjacent soft tissues, together with the medulla, become infiltrated with leucocytes, which have escaped from the vessels of the inflamed periosteum, medulla, and bone, and by proliferating tissue cells derived from these parts. The inflammation subsides in a few days, leaving the fragments embedded in a mass of soft, red, gelatinous material (*granulation-tissue*), derived from the leucocytes, lymphocytes, endothelial cells, and proliferated tissue cells, but according to some observers in part from the remains of the extravasated blood that has not been absorbed. This granulation-tissue, which is called *callus*, consists here, as in the union of soft parts, of small round cells and of larger connective-tissue and endothelial cells with a small amount of firm intercellular substance, and delicate loops of capillaries, which are derived in part from the vessels in the Haversian canals, and in part from the vessels in the periosteum and adjacent soft tissues. It is found (1) replacing the periosteum, and extending for some distance around the bone above and below the line of fracture, forming a spindle-shaped tumour, by which the ends of the fragments are surrounded, as it were, with a ferrule (*ensheathing or periosteal callus*, Fig. 46, A); (2) replacing the medulla for some little distance up and down the medullary canal (*internal or endosteal callus*, Fig. 46, B); and later (3) between the ends of the fragments (*permanent, intermediate or definitive callus*, Fig. 46, C). The ensheathing callus and internal callus are gradually organized into fibrous tissue, becoming harder and firmer, and in animals, and, in some instances, in children, are converted into cartilage or fibro-cartilage. The outermost layers of the fibrous tissue into which the ensheathing callus is thus converted, form a new periosteum. Ossification of the ensheathing callus now begins (twelfth to fifteenth day)—generally in the angle between the periosteum and the bone, and extends along the surface of the bone, where it is preceded by the formation of cells like osteoblasts, and also along the surface of the ensheathing callus beneath the



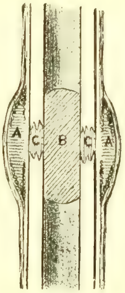


FIG. 45.—Diagram of the fragments a few hours after simple fracture. The periosteum is torn and ragged, and separated from the bone for a slight distance above and below the fracture. Blood is extravasated between the fragments, in the medullary canal, and in the periosteum and other soft tissues surrounding the fracture.

FIG. 46.—Diagram of the process of repair in simple fracture. A. Ensheathing callus; B. Internal callus; C. Permanent callus. Commencing ossification of the ensheathing callus is indicated by the darker shading at the angle between the periosteum and the bone.

new periosteum, till the upper and lower layers of ossifying callus meet opposite the line of fracture. Ossification of the internal callus goes on in a similar way, but begins a little later. Permanent callus, as soon as the ends of the bone are thus fixed by the ensheathing and internal callus, is formed between the ends of the fragments, and also undergoes ossification. It is probably derived (1) from leucocytes and lymphocytes which have escaped from the vessels in the enlarged Haversian canals of the inflamed and softened end of the fragments, and (2) from a proliferation of the endothelium and cells of the connective tissue lining these parts. The ossified callus is at first very vascular and porous, and can be easily stripped off the old bone, but later it becomes hard and dense, through the formation of new bone in its blood spaces, and intimately connected with the old bone beneath it. Finally the ensheathing callus and internal callus, having discharged their functions, are gradually absorbed, and if the fragments have been held in good apposition no sign of the fracture may ultimately remain.

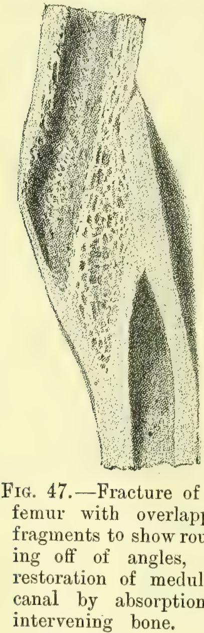


Fig. 47.—Fracture of the femur with overlapping fragments to show rounding off of angles, and restoration of medullary canal by absorption of intervening bone. (St. Bartholomew's Hospital Museum.)

Where the ends of the fragments overlap, the ensheathing callus fills up the angles (Fig. 47); and while the open end of the medullary canal in each fragment is thus closed, its continuity through the bone is restored by the absorption of the intervening walls of the contiguous and overlapping fragments (Fig. 47). When the fragments are in good apposition, and are kept at rest, little or no ensheathing callus is formed; but when there is much displacement, or rest is impossible as in a fractured rib, or difficult to obtain as in a fractured clavicle, a considerable amount is produced. In children, even when the parts are kept at rest and in good apposition, the formation of much ensheathing callus is the rule.

Treatment.—Here only the indications for treatment will be pointed out. The particular methods will be given under Special Fractures.

A. *Treatment of simple fracture.*—The indications are—(1) to reduce the fracture, that is, to place the fragments in apposition, so as to restore as far as possible the bone to its normal shape; (2) to keep it in this position by properly applied apparatus till firm union has occurred ; (3) to promote the restoration of the normal functions of the part; and (4) to attend in the meanwhile to the general health and comfort of the patient.

1. The *reduction*, or as it is popularly called, the setting, of the fracture, should not be undertaken until the apparatus into which the limb is to be permanently placed is ready ; but the fragments should be temporarily fixed so as to prevent further injury, such as a sharp fragment being forced through the skin. Thus, in the case of the lower extremity, the injured limb may be bound to the sound one, or secured by a handkerchief to an impromptu splint, such as an umbrella or walking-stick ; or if the patient is not seen till he is already in bed, the limb may be placed between sand-bags or wrapped in a pillow. As a general rule, the fracture should be reduced as soon as possible ; but where there is much swelling, the part may remain wrapped in a pillow or secured by sand-bags till the swelling has subsided. When the fracture is transverse, the fragments will, as a rule, be but slightly displaced, and little as regards reduction will be required. In other instances, as when the line of fracture is oblique, considerable trouble in bringing the fragments into apposition may be experienced. The chief obstacles to be overcome are (1) the contraction of the muscles, which are thrown into action by the irritation of the fragments ; and (2) the impaction of the fragments, or the interposition of muscle or tendon between them. The splint or other apparatus being in readiness, extension in the case of fracture of a limb should be made on the lower fragment, preferably, as a rule, through the intervention of the joint below. Thus, in fracture of the forearm or leg, extension should be made from the hand or foot respectively, whilst counter-extension is applied at the same time to the upper fragment, also preferably through the joint above. Whilst steady traction is thus being made, the surgeon should gently manipulate the fragments, and he should not rest satisfied till the symmetry of the part has been as far as possible restored and the limb is found, both on inspection and measurement, to correspond as near as may be with the opposite side. In this position the parts should be held till the apparatus for permanently fixing them has been applied. Where great difficulty is experienced in reducing the fracture owing to muscular spasm, the limb should be flexed or placed in such a position as will tend to relax the opposing muscles, or if this does not suffice an anæsthetic may be administered. At times the subcutaneous division of a tendon may become necessary before the fracture can be reduced. In some impacted fractures, as of the neck of the humerus or femur, it may be advisable not to disturb the fragments, as by so doing non-union, a worse condition than impaction, may result. The special methods of reduction which

may be required for certain fractures will be given under Varieties of Fracture.

2. *To keep the fragments in apposition* till union has taken place, numerous contrivances have been invented. They may be said to consist of splints, cradles, fracture-boxes, bandages hardened by plaster of Paris, silica, paraffin, glue, or gum and chalk, and such material as wire gauze, gutta-percha, poroplastic felt, and leather, moulded to the individual case. In oblique fractures, where the ends of the bone cannot be retained completely in apposition, Lane advises that an incision should be made down to the bone and the fragments secured by wiring.

The *method of applying splints* will be better learnt by three months' dressing in the wards than by any verbal description. The points that should be chiefly attended to are:—1. The splints should be well padded. 2. Pressure should not be made over points of bone. 3. Strapping or bandages should not be put on too tightly. 4. Circular constriction of the limb should be avoided. 5. The splints where possible should reach beyond both the joint above and the joint below the fracture. 6. The fracture should not, as a rule, be covered with the bandage. 7. The patient should be seen within twenty-four hours after the splints have been applied, as swelling of the part is apt to occur, and the bandages thus become too tight. 8. The part having once been properly secured in splints should not needlessly be disturbed. 9. Should the fragments become displaced from spasm of the muscles, steady extension as by a stirrup, weight, and pulley will usually overcome the difficulty. 10. The part below the fracture may sometimes be bandaged with advantage to prevent œdema.

After the splints have been applied, if the surgeon has any doubt as to the fragments being in proper apposition a skiagraph should be taken, with the part in the splints. If the reduction does not appear to be satisfactory the splints should be removed and the fracture re-set. The time the splints should be kept on varies greatly, and will be stated under each individual fracture. On their removal the limb should be kept at rest for some time longer in a plaster-of-Paris, gum and chalk, or other form of stiff bandage till complete consolidation has taken place. At some hospitals the fracture, if not severe, is placed at once in a plaster-of-Paris bandage or plaster-of-Paris splints (*Bavarian splints*). If this or other similar material is used, the limb should be well padded with cotton-wool, the toes or fingers left exposed, the joints above and below included in the bandage, and the limb subsequently raised. The patient should be visited a few hours after the plaster of Paris has been applied, so that should the circulation have become impeded from swelling of the limb, the plaster bandage may be removed before any serious damage has had time to ensue. The indications for at once removing, or for loosening the bandage by cutting it in places are :—1, much pain ; 2, swelling ; 3, numbness ; and 4, signs of obstructed circulation in the fingers or toes. A tight bandage, it should be remembered, is more dangerous in the upper than in the lower limb, because in the former most of the venous return is by the superficial veins. Should the bandage become loose, it must of course be removed, and reapplied. By some surgeons the plaster splint in the case of the leg is so applied and strengthened by strips of metal that the weight of the body is transmitted through the splint from some prominence of bone above the fracture to the ground below, and the patient is allowed at once to walk about. The slight rubbing of the fragments in the movement of the limb is believed to promote union, and the wasting of the muscles from the disuse following the ordinary treatment is avoided. This method, which is known as the *Ambulatory*, is much employed on the Continent.

3. *To promote the restoration of the normal functions of the part*, physiological after-treatment is required. Thus it will often be found after the apparatus is finally removed, especially if the fracture is near a joint, that the joint is stiff, the tendons are more or less glued together, and the muscles wasted and atrophied. Under these circumstances shampooing, massage, electricity, friction with stimulating liniments, and passive movements of the joint should be sedulously employed; but it is better to prevent such troubles occurring by resorting to active and passive movements and massage much earlier than has hitherto been the practice. Indeed, they may be begun with advantage after the first week except in fractures of the femur and humerus. Massage from the first is recommended by Lucas Championnière in fractures in the neighbourhood of joints.

4. *The general health and comfort of the patient* should not be neglected. Thus if he is confined to bed, boards should be substituted for the ordinary webbing or steel laths of the bedsteads ; the sheets should be kept smooth ; and bed-sores guarded against by the use of water-cushions and by hardening the skin over prominent points of bone with spirit lotions. Old people should not be kept too long in bed, lest passive congestion of the lungs occurs. The general health should be promoted by attention to the secretions, regulation of the diet, and administration of sedatives to relieve pain and promote sleep.

UNUNITED FRACTURE AND FALSE JOINT.—An *ununited* fracture is one in which the fragments are either totally ununited or merely bound together by fibrous tissue. Some fractures, such as transverse fractures of the patella, and fractures extending into joints in general, seldom or never unite by bone, but remain merely bound together by fibrous tissue ; but, as fibrous union here appears to be the normal method of repair, they are not, as a rule, spoken of as ununited fractures.

The condition of the fragments in an ununited fracture varies. The fragments may be completely separated, with the ends rounded off and the medullary canal closed ; or they may be bound together by long pliable bands of fibrous tissue permitting of considerable movement, or by tough fibrous bands allowing of but very little, or by a fibro-cartilaginous material—a kind of ensheathing callus. The last condition, however, is thought by some to be merely an example of *delayed union*, and not one of permanent ununited fracture.

A *false joint* or *pseudarthrosis* is merely a variety of ununited fracture in which the ends of the fragments are rounded off and eburnated, or covered with a layer of fibrous tissue or fibro-cartilage, and enclosed in a strong fibrous capsule formed by the condensation of the surrounding soft tissues (Fig. 48). A fluid resembling synovia has occasionally been found within the capsule. A false joint may resemble a hinge or a ball-and-socket joint. The latter condition is more common in fractures near the articular ends of bones, where rotatory as well as angular movement may occur; the former in fractures through the shafts of bones, where angular movement only is permitted.

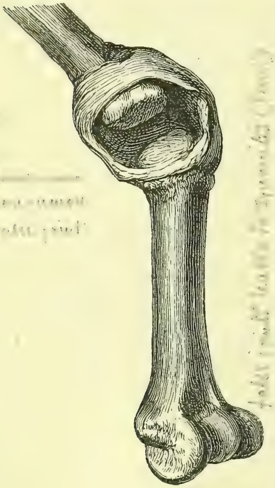


Fig. 48.—False joint following fracture of the humerus. (St. Bartholomew's Hospital Museum.)

The *Causes* are local and constitutional. The *local* are—1. The fragments not having been kept thoroughly at rest; 2. The fragments not having been placed in apposition in consequence of (*a*) muscular contraction; (*b*) the loss of a large piece of bone, as in compound fracture; (*c*) the intervention of a piece of muscle, tendon, or periosteum, or a foreign body, as a portion of clothes, between the fragments; and (*d*) the effusion of synovial fluid in the case of a fracture into a joint; 3. Necrosis of the end of one of the fragments ; 4. The interference with the arterial supply of one of the fragments, as from injury of the medullary artery; 5. The poor supply of blood to one of the fragments, as in fracture of the anatomical neck of the humerus; and 6. Defective nerve-influence, as sometimes occurs when the lower part of the spinal cord has been injured, with consequent disturbance of the trophic centres contained therein.

Constitutional causes.—Syphilis, tubercle, gout, Bright's disease, fevers, scurvy, the cancerous cachexia, pregnancy, locomotor ataxy, old age, alteration of the patient's habits, and sudden deprivation of stimulants are all said be to causes of ununited fracture. No doubt any condition that lowers the vitality and consequent power of repair of the tissues has a tendency to delay union, but it seems doubtful if any of the above conditions except scurvy is in itself, apart from the local causes, sufficient to prevent the bone uniting. Paralysis agitans, in which there is great difficulty in keeping the patient quiet, and hence of immobilizing the fragments by splints, &c., may also be regarded as a cause of non-union.

Sometimes the callus, after having been formed, appears to be re-absorbed, the fracture being then spoken of as *disunited*. This appears to be not uncommon in scurvy.

Treatment.—Constitutional as well as local treatment may be required. In recent cases, *i.e.*, where the fracture is found ununited after having been kept in splints for the usual time—a condition sometimes called *delayed union* in contradistinction to ununited fracture—the splints should be re-applied, and in such a manner as to insure perfect immobility of the fragments, whilst the general health should be improved by every means in our power, and any constitutional taint, as syphilis, gout, &c., that may be detected, combated by appropriate remedies. If the patient has been accustomed to stimulants, and has been deprived of them, he should be allowed a moderate quantity. In some cases it may be expedient to put the fracture in an immovable apparatus and let the patient get about on crutches. Should union still not occur, the end of the fragments should be rubbed together to excite some amount of inflammation, and splints or other apparatus be again applied. This failing, and in long-standing cases, two courses are open; either to try to unite the fragments by some operative procedure, or to apply some form of permanent apparatus to fix them in position. The choice of these methods will depend upon the situation of the fracture, and whether it is of the nature of an ununited fracture or a false joint (a point that should be ascertained by a skiagraph), and upon the patient's age, constitutional condition, occupation, and rank of life. Thus in the case of an ununited fracture of the upper third of the femur in a patient of advanced age or of broken constitution an operation is attended with great risk to life, and for such some form of apparatus is better suited. But when the patient is young, or of good constitution, or his occupation is such that he cannot afford an apparatus and the continual expense of keeping it in good order, and especially where the fracture is in the shaft of the humerus, an operation should be undertaken. Such operations may be divided into three classes, according as they have for their object—1, the setting up of inflammation about the ends of the fragments, or in the fibrous tissue uniting them, and so inducing ossification; 2, the fixation of the fragments by wire or other form of suture, by ivory cylinders, bone ferrules, &c.; and 3, the cutting out of the false joint, and bringing the refreshed surfaces of the bone into apposition, and keeping them there till union has occurred. Among the *first*, which are applicable to an ununited fracture rather than to a false joint, may be mentioned—(*a*) the subcutaneous scraping of the ends of the fragments; (*b*) passing a seton between them; and (*c*) cutting down upon and inserting ivory pegs into the fragments in order to induce ossification. Of these the subcutaneous method is, perhaps, attended with the least risk, but cases to which it is applicable are the exception. The passage of a seton is highly dangerous, and should never be employed. The insertion of ivory pegs for the purpose of inducing ossification is not reliable. Under the *second* method—namely, that of direct fixation of the fragments—are included (*a*) suturing the fragments; (*b*) the introduction of ivory cylinders into the medullary canal; and (*c*) fixation by bone ferrules. (*a*) Suturing, as formerly done, allowed of lateral and longitudinal displacement if the fracture was oblique. Wille therefore advises that in oblique fractures two grooves (Fig. 49) be cut with a saw in the fragments, the direction of the grooves being at a right angle to the fractured surfaces, and the fragments tied together with wire. Further, where both the fragments can be drilled vertically, he

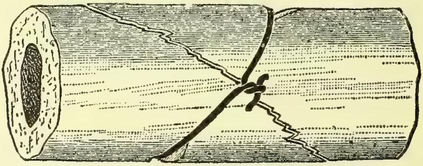


FIG. 49.—Wille's method of wiring the fragments in oblique fractures.

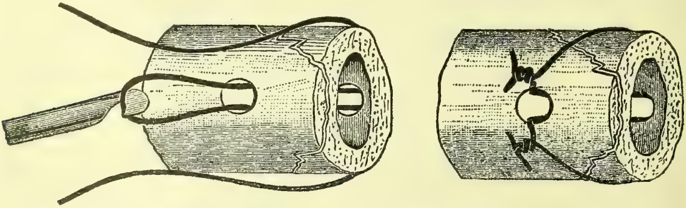


FIG. 50 and FIG. 51.—Wille's method of wiring the fragments in oblique fractures.

draws with a hook, invented for the purpose (Fig. 50), the wire through the drill holes, divides it, and twists each half together (Fig. 51). (*b*) The insertion of ivory cylinders, or, better, of hollow cylinders of bone, into the medullary cavity, is successful in fixing the fracture and preventing lateral and longitudinal displacement where the fracture is not too oblique. (*c*) Fixation with bone ferrules (Fig. 52) is advised by Senn. For the femur and humerus he employs the femur of the ox (Fig. 52, A); for the tibia, the tibia of the ox (Fig. 52, B). The ferrule should be a quarter of an inch to an inch in breadth, the medullary canal being enlarged by a round file till the ferrule does not exceed one sixth of an inch in thickness. When an inch broad it should be perforated as shown in Fig. 52 C, so as to facilitate its absorption after the fracture has united. If desired, it may be partially or completely decalcified. If the ferrule is too large the space between it and the fragments may be packed with small splinters of bone. The position of the ferrules when *in situ* is shown in Fig. 53. The *third* method, or operation for cutting out a false joint, consists in making an

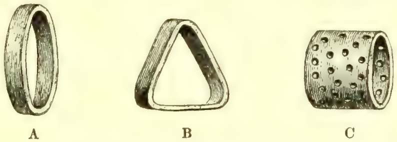


Fig. 52.—Senn's bone ferrules for fixing the fragments in ununited fractures. (After Senn.)

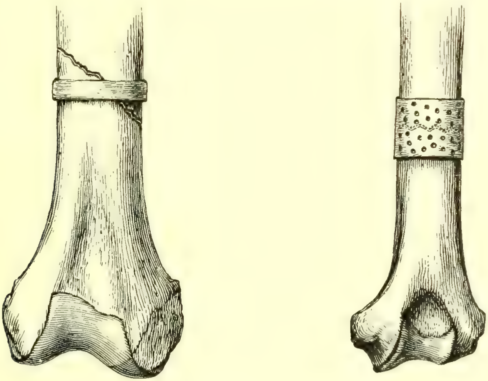


Fig. 53.—Senn's bone ferrules for fixing the fragments in ununited fractures *in situ*. (After Senn.)

incision down to the bone, chiselling or sawing away obliquely the ends of the fragments, and then fixing them in one of the ways above-mentioned.

Recently in ununited fractures with loss of substance from necrosis the gap has been filled by grafting a piece of bone between the fragments. The grafts may be obtained from a young animal, or from a limb immediately after amputation. In one successful case wedge-shaped pieces of bone, removed in osteotomy of the tibia, were used. Whilst being transferred the grafts should be kept at a temperature of 100° in a capsule of boiled salt solution (ʒj to Oj).

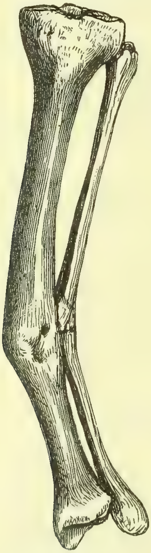


Fig. 54.—Malunited fracture. (St. Bartholomew's Hospital Museum.)

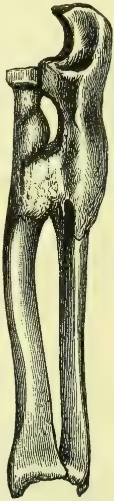


Fig. 55.—Vicious union after fracture. (St. Bartholomew's Hospital Museum.)

Malunited fracture or vicious union.—1. Fractures in consequence of having been improperly set, or not kept at rest in good position, may unite at an angle (Fig. 54), or in some other faulty direction. 2. If splints have been removed too early, or if in the case of the lower extremity the patient has been allowed to walk too soon, the callus may yield, and deformity result. 3. Two adjacent bones, as the radius and ulna in the forearm, may become united to each other by callus (Fig. 55). 4. A greenstick fracture from neglect to straighten the partially bent bone before applying splints may consolidate in its distorted condition.

Treatment.—If the fracture is recent, and the fragments are not firmly united, the patient should be placed under an anæsthetic, the faulty position rectified, and splints properly applied. If firm union has already occurred an attempt should be made to re-fracture the bone, under an anæsthetic, with the hands; if this fails, and in long-standing cases, osteoclasia by means of Grattan's or Thomas's instrument should be undertaken, or subcutaneous osteotomy may be performed, or in some instances a wedge-shaped piece of bone removed. In several cases of badly set Pott's fractures I have of late years divided the fibula subcutaneously and removed a wedge-shaped piece of bone from the internal malleolus with the most excellent results. A sharp fragment projecting beneath the skin may sometimes be sawn off with advantage, though it should be remembered that such projections often become rounded off with time.

SEPARATION OF EPIPHYSES.—This injury may be regarded as a variety of fracture. It consists in the forcible wrenching of the epiphyses from the shaft at their cartilaginous line of union, and consequently can only occur in subjects under twenty-one years of age, the period at which nearly all of the epiphyses have united with the diaphyses. The injury is most common in the upper and lower ends of the humerus, and, from the proximity of the epiphysial lines to the shoulder- and elbow-joints respectively, is liable to be mistaken for a dislocation. Repair usually takes place by osseous tissue; hence the bone ceases to grow at the injured end, and permanent shortening of the limb, if the patient has not completed his growth, will then result. Where the separation of an epiphysis occurs in such a situation as the lower end of the radius or tibia, the companion bone, *i.e.*, the ulna or fibula, as the case may be, continues to grow and becomes bent, its ends being held by its fellow. For treatment, see *Special fractures and dislocations.*

A COMPOUND FRACTURE is one in which there is a wound through the skin and other soft tissues leading to the fracture.

Cause.—The wound may be produced:—1. *At the same time as the fracture*, either by the violence directly tearing open the soft tissues, or, as is more usually the case, by one of the fragments being forced through the skin either by the original violence or by muscular contraction. 2. *Subsequently to the fracture*, by the patient trying to rise or to use the injured limb; or by want of care in removing the clothes, in handling the fracture, or trying for crepitus. 3. *Still later*, by ulceration or sloughing of the soft parts, due to inflammation set up through failure to render and keep the injury aseptic, and the laceration of the tissues or the pressure of a projecting fragment.

State of the parts.—There may be a mere puncture, with but little if any more injury to the soft tissues than may be met with in simple fracture; or with or without a large external wound of the skin there may be extensive laceration of the soft tissues, protrusion of one or other fragment, extensive comminution of the bone, implication of a large joint, rupture of the main artery, vein, or nerve, and, in extreme cases, crushing and laceration of the whole of the injured part of the limb.

Union of compound fracture.—When the wound is small, and has been closed at once, and the soft parts are but little injured, and septic or other bacterial processes are absent, repair is as a rule similar to that of a simple fracture. When the wound is large, or there is much laceration of the soft tissues or comminution of the bone, suppuration is very likely to ensue, and union is then effected by granulations springing from the ends of the fragments and periosteum, the process being analogous to union of the soft parts by the second intention. The granulations either undergo direct ossification, or first pass through a fibrous, or, in some instances, a cartilaginous stage. The loose fragments and injured tissues, where the bone is comminuted and the soft parts are much bruised or lacerated, are cast off by the process of ulceration (Fig. 56) before healing ensues. Where, however, a fragment retains its connection with the periosteum, it may not lose its vitality, but may help in the restoration of the bone. Where a large portion of bone is denuded of periosteum it generally dies, and is usually separated as in the ordinary process of necrosis (Fig. 56). It may, however, become embedded in the new bone, and remain a source of irritation for years.

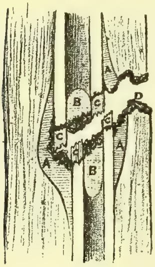


FIG. 56.—Diagram showing process of separation of necrosed bone in compound fracture. A. Ensheathing callus; B. Internal callus; C. Necrosed fragments; D. Granulations lining wound leading to fracture. (After Billroth.)

Dangers of compound fracture.—1. *Immediate dangers:* shock and collapse from loss of blood, which may prove fatal in a few hours; more rarely fat-embolism. 2. *Intermediate dangers:* septic inflammation, erysipelas, sapræmia, septicæmia, pyæmia, and tetanus. 3. *Late dangers:* hectic fever, lardaceous disease, and exhaustion from long-continued suppuration.

The treatment varies according to the state of the parts, the age and health of the patient, and the situation of the fracture. Our aim, when possible, should be to convert a compound into a simple fracture. Thus, when the wound is small—a mere puncture—it should, after being well cleansed by antiseptics, be closed by a piece of antiseptic gauze, and the case treated as a simple fracture.

When the wound is large and lacerated, or other serious injury of the bone, soft parts, or neighbouring joint has been sustained, the question of amputation will arise. (See below, *Amputation in Compound Fracture.*) Having, however, determined to save the limb, the indications are—(1) to reduce the fracture and maintain the fragments at perfect rest; and (2) to promote the healthy healing of the wound. The fracture should be set as described under simple fracture; if the fragments protrude they should be reduced where practicable, sawn off where not, enlarging the wound in the skin if necessary, but taking care not to remove more bone than is sufficient to accomplish the object. Splinters when attached by periosteum should not be removed, but simply placed in position and then secured, under some circumstances by sutures. If it is found difficult to keep the fragments in place they may be fixed in position by wiring or by Senn's bone ferrules (page 169). The wound should be rendered aseptic by washing out all corners with some antiseptic fluid. When this can be thoroughly done the soft tissues, muscles, tendons, and fasciæ should be united by catgut sutures and the wound closed; but when there is much laceration, and thorough cleansing cannot be effectually carried out, the wound should be kept freely drained to prevent the decomposition of any extravasated blood and discharges. The limb should then be secured in some form of apparatus, so arranged that the wound is not covered by it, but is freely accessible for dressing without disturbing the fragments. If the patient's general condition remains good, and he has no pain or discomfort, the dressings may be left undisturbed till the wound has healed; but should suppuration occur, a careful inspection ought to be made daily to see that the drainage is efficient; and if any collection of pus, which is apt to form in the intermuscular planes, be discovered, it should be let out with antiseptic precautions and the wound drained. Any portions of bone that may necrose should be removed as soon as loose. When the wound has healed the fracture should be treated in the same way as a simple one. Any complications, as erysipelas, sapræmia, &c., that may occur, must be treated as described in other parts of the book. The *constitutional treatment* is the same as that indicated in other severe injuries. (See also *Simple Fracture.*)

Question of amputation in compound fracture.—In slight and uncomplicated cases, and in those severe injuries in which the limb is completely shattered, the course to be pursued is quite clear—in the one case to spare the limb, and in the other to amputate immediately. But in other instances the question of attempting to save *versus* amputate becomes one of the most serious and anxious that the surgeon has to decide. It was formerly taught that we should amputate—1. If there is great laceration of the soft parts and extensive loss of skin. 2. If there is much comminution of the bone. 3. If the main artery or nerves of the limb are torn. 4. If a large joint is implicated. 5. If the limb is likely to be of little subsequent service from the severity of the injury; and 6. If the patient is old or his constitution broken down. No one of these signs is in itself in every case a sufficient reason for amputating, and when we can succeed in rendering the wound completely aseptic some of them, as comminution of the bone, implication of a large joint, and the advanced age of the patient, can hardly be now ever considered as a justification for so severe a measure. The main considerations are: Can the wound be rendered aseptic, and, if so, is the arterial supply sufficient to prevent gangrene; is the condition of the nerves such that the limb will not be helplessly paralysed; and is the laceration of the muscles and tendons within such limits as will allow of a useful limb? If these questions can be answered in the affirmative an attempt should be made to save the limb; if in the negative, amputation should be done. The indications for amputation are of course more imperative if the fracture involves the lower extremity, especially the femur; but each case must be judged on its own merits, and some surgeons will attempt to save what others condemn. Every legitimate effort should of course be made to save a limb, but we must remember that in attempting to do so we may place the patient's life in danger, and that too often it is a question of a limb *versus* the life.

If amputation is not performed at once, or within the first twenty-four hours, and it then becomes evident that the limb must be sacrificed, the amputation should not, as a rule, be undertaken till the traumatic fever has subsided, the surgeon watching carefully for the most favourable opportunity that presents itself. The signs calling for amputation during the suppurating stage are:—Extensive suppuration, great sloughing of the soft tissues, inflammation and suppuration of a neighbouring joint, necrosis of large portions of bone, exhaustion, hectic, and lardaceous disease.

COMPLICATIONS OF FRACTURE.—A *simple fracture* may be complicated by any of the *general affections* attending other injuries, as shock, traumatic delirium, tetanus, retention of urine; and by such *local conditions* as, 1, concomitant dislocation; 2, extravasation of blood; 3, rupture of the main artery, vein, or nerve; 4, implication of a joint; 5, gangrene from tight bandaging; 6, paralysis from the use of a crutch, or the implication of a nerve in the callus; 7, venous thrombosis; 8, embolism; 9, formation of ulcers or bed-sores over prominences of bone; 10, erysipelas; 11, fat-embolism; and, 12, suppuration where there is much laceration of the tissues with giving way of the skin, the fracture then becoming compound.

A *compound fracture* may in consequence of the open wound be complicated, in addition to the above-mentioned affections, by *septic inflammation* and *suppuration*, *necrosis*, *sapræmia*, *septicæmia*, *pyæmia*, *hectic fever*, and *tetanus*.

Of these complications of fracture, whether simple or compound, the only ones that need be further mentioned here are the following :—

Fracture combined with dislocation.—In simple fracture the treatment consists in placing, where possible, the fracture in splints, and then attempting the reduction of the dislocation. Where the dislocated end cannot be replaced the fragments must be allowed to consolidate, and another attempt then made to reduce the dislocation; or the surgeon may try to manipulate the dislocated portion into its socket, and then apply splints to the fracture. In compound fracture this complication is a much more serious one, especially when it occurs in the lower extremity and involves one of the larger joints. In the knee, ankle, and wrist, amputation, and in the elbow and shoulder, excision, is usually indicated. In the smaller joints the dislocation may be reduced, and the case treated as a wounded joint complicated by fracture.

Fracture implicating a joint.—A simple fracture extending into a joint is not an uncommon accident; indeed the elbow and knee-joints are always involved in fracture of the olecranon and patella respectively, and the shoulder and hip-joints in the intra-capsular fracture of the neck of the humerus and femur. The injured joint may become stiff or ankylosed, though usually no serious mischief ensues. Suppuration is very rare. The limb, in putting up the fracture, should be placed, except in the case of fracture of the olecranon, in a position in which it will be of most service should bony ankylosis ensue. Inflammation and stiffness of the joint from fibrous adhesions should be treated in the way described under Diseases of Joints. A compound fracture extending into a joint, though more serious, does not necessarily call for amputation or excision, and may be treated in the way described under Wounds of Joints. But should such be required, excision in the upper extremity and amputation in the lower may be said, with certain reservations, to be the rule of practice. If an operation is considered unnecessary the case should be treated as a wounded joint, and splints, according to the variety of fracture, applied.

Fat-embolism is a rare complication of fracture, but is more frequent in the compound than in the simple variety and in bones that have undergone atrophy. It appears that in consequence of the crushing of the medulla, fat-globules gain admission into the veins, and become lodged in the capillaries of the lungs, brain, kidneys, and other organs. It is attended by dyspnœa, either cyanosis or pallor, collapse, irregular action of the heart, and at times by coma and death. Venesection, injection of ether into the veins, and artificial respiration have been suggested in the way of treatment.

Crutch-palsy is due to the pressure of a crutch on the musculo-spiral nerve. It is best avoided by well padding the crutches, or by having handles to the crutches, so that part of the weight falls on the hands. An ingenious crutch with handles has lately been introduced. The paralysis, which chiefly affects the extensor muscles of the forearm, giving rise to *dropped wrist*, usually passes off when the crutch is no longer used. Should it not do so, electricity and massage may be employed.

Paralysis or *neuralgia* sometimes occurs in consequence of the implication of a nerve in the callus. This condition is perhaps most common in fractures of the shaft of the humerus, the musculo-spiral nerve being involved in the callus as it lies in its groove. The result is dropped hand from paralysis of the extensors of the wrist and loss or impairment of sensation or pain, and trophic changes in the region supplied by the radial branch. An operation is then at times necessary to liberate the nerve.

Gangrene from tight bandaging is occasionally met with, and is of the moist variety. All bandages should of course be at once removed in the hope that the limb may recover. When the gangrene is thoroughly established, amputation above the seat of fracture, and of course well beyond the gangrene, must be performed. Short of gangrene, the partial cutting off of the blood supply may cause inflammation and degeneration of the muscles, followed by stubborn contracture (*ischæmic rigidity*).

Extravasation of blood into the tissues is not uncommon in simple fracture, owing to the tearing of some of the smaller blood-vessels by one of the rough fragments. The extravasated blood causes in some instances considerable swelling, and on making its way to the surface gives the part a bruised and black appearance, and frequently causes the cuticle over it to be raised into blebs. These blebs differ from those formed in gangrene in that they are fixed and firm, whilst the latter are movable over the moist and slippery skin beneath. No special treatment is required, the blebs should not be opened, and the blood will gradually be absorbed. In rare instances, however, suppuration ensues.

Rupture of the main artery or vein occasionally occurs, causing when the skin is unbroken a tense swelling at the seat of fracture, attended, in the case of the artery, by coldness of the limb and cessation of the pulse in the arteries below. In compound fracture rupture of the artery is, as a rule, easily diagnosed, in that pressure on the artery above the fracture stops the bleeding. *Treatment.*—Should the swelling in simple fracture increase in spite of elevation of the limb, cold, and pressure on the main artery above, and gangrene threaten, three courses are open: 1, ligature of the artery above; 2, tying the artery at the seat of fracture; or, 3, amputation. In the lower limb amputation is probably, as a rule, the safest course; in the upper limb ligature of the vessel at the seat of fracture may be attempted. But the conditions that call for the adoption of one or other of these methods are too various to discuss here. In compound fracture the vessel should be tied in the wound if possible. If not, amputation will probably, though not invariably, be the right course.

INJURIES OF JOINTS.

CONTUSIONS of joints may be produced by any mechanical violence. They are generally attended with pain and stiffness on movement, and in severe cases with swelling from effusion of blood (*hæmarthrosis*), and, later, of serous fluid (*synovitis*) into the synovial cavity. If the contusion is neglected, especially in tuberculous children, acute or chronic inflammatory changes may ensue, leading to destruction of the joint. *The treatment* consists in placing the part at rest on a splint, or in a plaster-of-Paris bandage, and applying cold by means of an ice-bag or Leiter's tubes. Where there is much effusion into the synovial cavity, and consequently considerable tension and pain, aspiration of the joint may be advantageously practised, and pressure afterwards applied.

SPRAINS.—A sprain is a stretching or partial rupture of the ligaments of a joint without separation of the articular surfaces. Sprains are generally due to a violent wrench or twist of the joint, and are often accompanied by laceration of the tendons and other soft tissues around. They are of most frequent occurrence in the ankle, shoulder, wrist, and knee.

Signs and diagnosis.—Severe pain, often localized to certain points, and increased on movement; inability to bear weight on the limb; swelling and ecchymosis from effusion of blood in and around the joint; and, later, inflammatory effusion into the synovial cavity. The absence of signs of fracture or of dislocation will usually suffice to distinguish a sprain from one or other of these injuries; but where there is much swelling it may be difficult or impossible to make a diagnosis till the swelling has subsided. If there is any doubt the injury should be treated as a fracture.

The consequences of a neglected sprain may be very serious, especially in rheumatic and gouty subjects. Thus, as the result of the incomplete absorption of the inflammatory products, the imperfect repair of the torn ligaments, the formation of fibrous adhesions in and around the joint, and the gluing of the surrounding tendons to their sheaths, a sprain may be followed by long-continued pain, stiffness, weakness, and even fibrous ankylosis of the joint. At times in tuberculous subjects a sprain may be the starting point of destructive joint-disease.

Treatment.—The indications are to place the joint at perfect rest ill the torn ligaments have had time to heal; to prevent or subdue inflammation; and, should stiffness or ankylosis have ensued, to restore the mobility of the joint by breaking down any adhesions that may have formed. Thus, if seen at once, a plaster-of-Paris or a Martin's bandage should be put on; or if much swelling has already occurred, the parts should be placed on a splint, or in a sling, and either cold, in the form of lead-lotion or ice, or heat, in the form of hot fomentations, applied. For very slight cases, however, a few days' rest with the part supported by a wet bandage, followed by the use of a stimulating liniment, is all that is usually necessary. The joint in any case should not be kept too long at rest lest stiffness ensue; but as soon as all signs of inflammation have disappeared passive movements should at once be begun. If stiffness or fibrous ankylosis has already occurred, friction, shampooing, and massage may be tried; or the joint may be forcibly wrenched under an anæsthetic, provided all signs of active inflammation have ceased.

Dislocations.—A dislocation is the forcible separation of the articular end of a bone from the part with which it is naturally in contact.

Varieties.—Dislocations may be divided into the *Congenital* and the *Acquired;* the latter again into the *Spontaneous* and the *Traumatic.* The *Spontaneous* are those that occur as the result of disease of the joints, and are treated of elsewhere (see *Diseases of Joints*). The *Traumatic*, or accidental dislocations, with which we are here specially concerned, are spoken of as *compound* or *simple* according as they are, or are not, complicated with an external wound leading into the joint; and in either case as *complete* or *partial* according as the articular surfaces are, or are not, completely separated from each other.

The causes of dislocation are predisposing and exciting. *The predisposing causes* may be enumerated as:—1, weakness of the ligaments surrounding the joint from previous dislocation or disease; 2, the shape of the joint—ball-and-socket joints from their extensive range of movement being more easily dislocated than hinge joints; 3, middle life—the bones being then strong and capable of resisting fracture and the muscles powerful; 4, the male sex—men being more continually exposed to violence than women. *The exciting causes* are usually, 1, external violence, either direct or indirect, and sometimes, 2, muscular action. Examples of each will be met with in the section on special dislocations.

The Signs common to all dislocations are:—1. Alteration in the shape of the joint. 2. Inability to move the limb on the part of the patient, and more or less fixidity to the efforts of the surgeon. 3. An alteration in the relations of points of bone about the joint. 4. An abnormal position of the end of the displaced bone; and 5. Shortening or lengthening of the limb, or an alteration in its axis. The signs are frequently obscured by swelling in and about the joint, due to extravasation of blood or effusion of synovial fluid. Hence in all doubtful cases the position of the bone should be ascertained by means of the *x* rays.

The state of the parts will be more especially referred to under each special dislocation. Here it may be briefly stated that the head of the bone is generally forced through the capsular ligament; whilst other of the ligaments, surrounding tendons, and muscles, may be ruptured or tightly stretched, and the arteries and nerves displaced, pressed upon, or torn. In the ball-and-socket joints the end of the bone will be found either opposite the rent in the capsule or drawn to some distance from it by muscular contraction. If reduction is effected early, the damaged ligaments and muscles are soon repaired; but they remain for some time weakened and stretched, and thus predispose to re-dislocation. Hence the importance of keeping the parts at rest until firm union of the ruptured capsular and other ligaments has occurred. After reduction a moderate amount of inflammation and serous effusion in and about the joint generally ensues, but usually subsides in a few days if the parts are kept at rest, the joint becoming gradually restored to its normal condition. If rest is neglected, however, the rent in the capsule may not heal, but remain as a permanent hole with smooth edges, allowing the head of the bone to slip in and out of its socket. In some instances, moreover, the inflammation may run into suppuration, which may be followed by ankylosis of the joint.

The impediments to reduction are:—In *recent cases*:—1. The spasmodic contraction of the muscles surrounding the joint. 2. The small size of the rent in the capsule. 3. The hitching of points of bone on each other; and 4. The interposition of ligaments, tendons or muscles. In *old-standing cases*:—1. The formation of adhesions around the displaced bone. 2. The closure of the rent in the capsule. 3. The permanent shortening of the ligaments and muscles; and 4. The alteration in the shape of the articular surfaces, in part from absorption and in part from the formation of new bone. The contraction of the muscles generally increases from the time of the accident; hence every hour the dislocation remains unreduced the more difficult the reduction becomes.

The consequences of non-reduction are either the formation of a new joint or ankylosis, the former being more common in ball-and-socket joints, the latter in hinge joints. When any movement between the dislocated bones exists, the osseous surface on which the displaced bone rests is converted into a new articular cavity by a process of absorption of the old bone and the formation of new bone around; the end of the displaced bone becomes adapted by a similar process of absorption to its new socket; and the soft tissues around become condensed so as to form a kind of new capsule. The old socket in the meantime becomes more or less obliterated, its articular cartilage absorbed, and its cavity filled up with fibrous tissue or new bone. The range of movement in the newly formed joint will at first be limited, but in the course of time, under appropriate treatment, will become much more free, and a very fairly useful limb may be obtained. When on the other hand the dislocated bone is immovably fixed upon another the articular cartilage is absorbed, the contiguous osseous surfaces unite, and bony ankylosis ensues. The muscles, moreover, from want of use, undergo shortening or partial atrophy and fatty degeneration, leaving the limb in a more or less shrunken and wasted condition.

Treatment.—The indications are:—1. To replace the articular surfaces in contact; and 2. To keep them there until the rent in the capsule has united and the torn ligaments and muscles have had time to heal. Unless the case is seen immediately after the accident, whilst the patient is faint and the muscles are in consequence relaxed, an anæsthetic had better be given to overcome the resistance of the muscles. The reduction may then be effected either by, 1, *manipulation*, or, 2, *extension.*

1. *Manipulation* consists in putting the limb through certain movements of flexion, extension, rotation, and circumduction, varying according to the situation and variety of the dislocation. By means of these movements we endeavour:—(*a*) To overcome the obstacles to reduction by relaxing the stretched ligaments and tendons and disengaging any hitching points of bone; and (*b*) To make the displaced head retrace as it were its steps and re-enter its socket. In order to employ manipulation successfully it is essential that the surgeon should know the anatomy of the part, the direction in which the bone has travelled to reach its abnormal situation, and the probable position of the rent in the capsule.

2. *Extension* is a much less scientific method of reducing a dislocation, and should never be resorted to except in certain forms of dislocation, which will be mentioned hereafter, till manipulation has been tried. It was the method almost always employed by the older surgeons, and has for its object the forcible dragging of the displaced end of the bone into its socket, or opposite its socket, into which it is then drawn by muscular contraction. In many forms of dislocation the method is as harmful in practice as it is wrong in principle, since the displaced head, as in some forms of dislocation of the hip, can only be drawn into its socket in this forcible manner by rupturing the resisting ligaments and tendons. In employing extension, traction is made in the long axis of the limb by the surgeon, either with his hands or by means of a jack-towel secured by a clove hitch to the limb, or if more force is required by multiplying pulleys. Counter-extension is in the meanwhile made in the opposite direction to the extending force, but in the same straight line, either by the surgeon pressing with his heel or knee

on the part above the dislocation, or by fixing the part with a jack-towel or suitable strap to a hook in the floor or wall. When sufficient extension has been employed to draw the head of the bone opposite its socket the surgeon should endeavour to guide it into its place. Before the introduction of chloroform this was usually effected by the contraction of the muscles themselves after the head had been drawn down by the extending force.

In old-standing cases, before either manipulation or extension is employed, the adhesions, which offer the chief obstacle to reduction, should be first broken down by cautiously rotating or circumducting the limb. When the rent in the capsule has united, the old socket been filled up, and a new joint formed, reduction is of course physically impossible; but even then the breaking down of the adhesions may greatly improve the range of motion and consequent usefulness of the limb. In attempting the reduction of a long-standing dislocation, however, great care must be exercised, or irreparable damage may be done. Rather than use any great violence it is in some cases better at once to cut down upon the dislocation and divide any bands which may be found preventing reduction. Not only may the accidents below enumerated be thus avoided, but reduction may be safely accomplished at later periods than was formerly possible, and with antiseptic treatment of the wound there is but little risk, and good movement of the joint may be expected.

Among *the accidents that have attended violent efforts at reduction* may be mentioned:—1. Rupture of the main artery, vein, or nerves. 2. Laceration of muscles and tendons. 3. Tearing open the skin and soft tissues, thus rendering the dislocation compound. 4. Fracture of the bone. 5. Inflammation and suppuration of the joint and surrounding parts; and 6. The evulsion of the limb.

How long after a dislocation may an attempt be made at reduction?—Sir Astley Cooper gave the time at between three and four months; but since the introduction of chloroform successful cases have been reported after much longer periods. In an old-standing case the circumstances which should influence us in deciding whether an attempt at reduction should be made, are the age of the patient, the situation of the dislocation, the presence or absence of pain, and the amount of usefulness of the limb. By the new method of open division of the adhesions about the joint, the time at which a dislocation can be reduced is considerably extended. This method, however, should not be employed unless the movements of the joint are restricted and the usefulness of the limb in consequence is impaired.

The *after-treatment* consists in maintaining the part at rest by suitably applied strapping and bandages, and in preventing or subduing inflammation by cold, evaporating lotions, &c. The part, however, should not be kept at absolute rest longer than is sufficient for the torn ligaments and other soft tissues to heal, lest adhesions form and stiffness of the joint ensue. Passive movements, therefore, should be cautiously begun after a few weeks; and friction, shampooing, or galvanism subsequently employed to restore the tone of the wasted muscles. Where stiffness has occurred the adhesions should be broken down under an anæsthetic, provided there are no signs of active inflammation in the joint.

Treatment of compound dislocations.—The dislocation should be reduced, the parts placed at perfect rest, and the case treated as a wound of the joint (see *Wounds of Joints*). In consequence of the extensive laceration of the ligaments and other soft tissues reduction is usually quite easy. When a compound dislocation is combined with a fracture of the bone, and there is much laceration of the soft parts, amputation of the limb in the lower extremity, and resection of the joint in the upper, will probably be required.

CONGENITAL DISLOCATIONS are those that occur during intrauterine life, and generally depend upon some malformation of the articular surfaces, rather than upon actual displacement of an originally normal articulation. They are all very rare, with the exception of the so-called "congenital dislocation" of the hip, which requires a separate notice.

CONGENITAL DISLOCATION OF THE HIP.—In this deformity the acetabulum and head of the femur are malformed, the head of the bone resting usually on the ilium. The chief signs are a waddling gait, lordosis, and shortening of the limb if the dislocation is one-sided. On examination the trochanter is found to be prominent and above Nélaton's line, but it can be drawn down somewhat on making traction on the limb. The head of the bone can usually be felt in the abnormal position. After the child begins to walk the muscles become contracted and the head forced further from the acetabulum by the weight of the body.

Treatment.—Continuous extension in the horizontal position with pressure over the trochanter has been attended with considerable success. During the last few years several operations have been practised for congenital dislocation of the hip by Lorenz, Hoffa, Ogston, and others. Briefly, these operations consist in the division of contracted muscles and ligaments, the gouging out of a new acetabulum in the ilium, and the replacement of the remains of the head of the femur in the new socket thus formed. It is questionable, however, if the results obtained are worth the risk. In young children the remains of the head may be often replaced in the rudimentary acetabulum by manipulation (*Paci's method*), or may be brought near that cavity. In either case the limb should then be fixed in the abducted position, so that the pressure of the head may deepen the old or make for itself a new socket.

Wounds of joints.—A joint may be merely punctured, or it may be laid freely open. The wound may be of an incised, lacerated, or contused character, and complicated by extensive injury of the surrounding soft tissues, or by dislocation or fracture of the articular ends of the bones. In the latter case the wound may be further complicated by the protrusion of the dislocated bones or the ends of the fragments.

A wound of a large joint should always be regarded as serious, as owing to the difficulty of securing an efficient drain, and of preventing decomposition of the extravasated blood and serous secretion in the synovial pouches, septic or infective inflammation is very liable to be set up, and rapidly run on to suppuration and disorganization of the joint. The peculiar absorptive power of the synovial membrane, moveover, favours the entrance of the chemical products of decomposition into the system, and consequently enhances the risk of septic poisoning, to which, or to such infective processes as septicæmia or pyæmia, the patient may succumb. Further, should he survive these earlier dangers of blood-poisoning, he is still liable to fall a victim to hectic, or to exhaustion or lardaceous disease consequent upon the prolonged drain on the system attending the suppuration in the synovial membrane, the articular ends of the bones, and the surrounding soft parts.

Medium-sized wounds are the most dangerous, as such cannot always be rendered aseptic nor drainage be effectually secured. Punctured wounds, when made with a clean instrument, and in an oblique direction, may heal under appropriate treatment without any inflammatory or other trouble. Should septic or infective germs, however, gain admission at the time of puncture, or subsequently through neglect of the wound, or should the joint not be kept properly at rest, a punctured wound may be followed by the most intense inflammation of the synovial membrane, and total disorganization of the joint with its attendant dangers of blood-poisoning. Extensive and lacerated wounds of joints, when not sufficiently severe to call for amputation or excision, are not necessarily a source of extreme anxiety, as they usually permit of effectual cleansing and drainage, and under the use of antiseptics may heal up by granulations without giving rise to any serious constitutional disturbance. In such cases, however, bony ankylosis will generally ensue, though in some instances the cartilages may escape destruction, and a fairly movable and useful joint may be obtained.

Signs.—When the joint is laid freely open the nature of the injury is obvious, and any displacement or splintering of the bones can be seen or ascertained by examination with the finger. When the wound is of a punctured character and the incision in the skin is some distance from the joint the signs are not always so apparent. In such cases an account of the depth to which the instrument penetrated, and of the direction in which it appeared to run, will help us to determine whether the synovial membrane has been entered. The escape of a glairy fluid like the white of egg—the synovial secretion—will make the diagnosis certain. If in doubt the case should be treated as if the joint had been opened, but on no account should the wound be probed for the purpose of settling the point, since septic matter might be introduced from without, and a wound that did not in the first instance penetrate the cavity might be made to do so. Should inflammation ensue the signs will be the same as those of acute arthritis (see *Diseases of Joints*).

The *treatment* will depend on the size and character of the wound, the joint affected, the nature of the complications, and the age and constitution of the patient. The chief indications are to prevent inflammation and its attendant consequences, or if the injury is of a very severe character, to endeavour to save the patient's life by the sacrifice of his limb. Thus, if the wound is small and uncomplicated, an attempt should be made to convert it into a subcutaneous wound by sealing it with iodoformized collodion, or better, by placing over it an antiseptic dressing, after having first thoroughly cleansed the skin and rendered it aseptic. One or more fine silkworm-gut sutures may first be inserted if the wound is too large to be closed in this way. The limb should be then placed on a splint at perfect rest, and cold applied by means of an ice-bag or by Leiter's tubes. Should inflammation follow, half-a-dozen leeches should be placed over the joint, and warm applications substituted for the cold; whilst, should the local and constitutional disturbance increase and the joint become distended, aspiration should be practised to relieve tension, opium given to soothe the pain, and the treatment persevered in. If, however, *pus* is withdrawn by the aspirator, the joint should be laid freely open, drained, dressed antiseptically, and placed in the position in which, should ankylosis ensue, it will subsequently be of most use. If, notwithstanding free incisions, the suppuration goes on, continuous irrigation with some weak antiseptic fluid may be tried, or the whole limb kept continuously in a hot bath, the patient, if necessary, as in the case of the knee, being himself immersed. Should signs of sapræmia or exhaustion from hectic set in, amputation must be performed.

Larger wounds of joints, especially when lacerated, should be thoroughly cleansed with antiseptic lotions, well drained, and dressed antiseptically. A counter-opening at a dependent spot may in some cases be advantageously made, as for instance in the popliteal space in wounds of the knee, and a tube passed through the joint. Where there is extensive laceration of the soft parts and much comminution of the bones, such as may be produced by a bullet, where there is a probability of the introduction of septic material as on pieces of clothing, or where there are other complications of such a nature as to render it doubtful whether a useful limb can be obtained, the question of amputation or excision must be raised. In deciding on the propriety of an operation the surgeon will be influenced by the situation of the joint, whether it is septic or not, and the probable power of the patient, either on account of his age or the general state of his constitution, to stand the acute inflammation and prolonged suppuration which must almost necessarily ensue if the limb is not removed. Briefly it may be said, that an injury which in the elbow might be treated in the ordinary way or by excision of the joint, would in the knee probably call for amputation; that a wound of the wrist is generally more serious than one of the ankle; and that the sacrifice of the limb is required for a much less severe wound of the knee than of the ankle.

INJURIES OF MUSCLES AND TENDONS.

Contusions of muscles are very common as the result of falls, blows, kicks, or other violence. They may vary from a slight bruising with or without tearing of the muscle-fibres and blood-extravasation to complete pulping of the muscles. *Signs.*—In the slighter cases there is dull aching pain increased on movement, ill-defined and deep-seated swelling, and later, ecchymosis as the blood makes its way to the surface. Some stiffness or loss of power from partial atrophy frequently follows, and occasionally inflammation and abscess. Severe cases are frequently associated with other injuries of the part, as fracture of a bone, laceration of a large blood-vessel, &c. The *treatment* consists in keeping the part at rest with the muscle as much as possible relaxed, and in preventing inflammation by cold, lead and opium lotions and the like. Shampooing, massage, and galvanism may subsequently be necessary to restore any loss of power that may ensue.

Wounds of muscles may be incised, lacerated, punctured, or contused. When the wound is made transversely, the divided ends, which gape widely, must be approximated by placing the limb in such a position as will relax the muscle, and then united by aseptic sutures. When the wound is deep or parallel to the fibres a drainage-tube may be inserted to prevent the retention of the discharge by the bulging of the muscle. Union takes place by fibrous tissue.

Rupture of muscle may occur from a sudden and violent spasmodic action, or during vomiting, tetanus, or delirium. As examples may be mentioned rupture of the sterno-mastoid of the child in a difficult labour, the rectus abdominis in parturition, the biceps in raising weights, the supinator longus and gastrocnemius in lawn tennis, the quadriceps extensor at football, and the adductors of the thigh in riding. A sensation of tearing is often felt at the moment of rupture, followed by pain and, if the rupture is complete, by loss of function. The rupture is indicated by a gap, above and below which is felt a swelling formed by the ends of the retracted muscle; or blood is extravasated between the ruptured ends, occasioning a hæmatoma. Rupture of the sterno-mastoid in infancy is said to be followed by contraction of the muscle and consequent wry-neck. The *treatment* consists in approximating the divided ends as much as possible by position and by suitable bandages and splints, and in applying ice and evaporating lotions to control the blood extravasation and to prevent inflammation. If a blood tumour forms it should not be opened, unless suppuration occurs.

Wounds of tendons may be divided into the subcutaneous and the open. The former are discussed under *Tenotomy*. When a tendon is divided in an open wound its cut ends should be approximated by placing the parts on a splint in such a position that the muscle is as much as possible relaxed, and the divided ends then united by aseptic sutures. In long-standing cases an attempt may also be made to unite the cut tendon if the patient's general state of health is favourable and there is no evidence of extensive destruction of the tendon or of its adhesion to the neighbouring structures. When the ends of the divided tendon are found to have retracted and to be so far apart that they cannot be made to meet, one end may be split longitudinally, but not quite to the divided end, turned down and united to the other end by suture. In some cases where the divided ends will not meet they may be united by a leash of catgut. In other cases, as in the tendons of the fingers, the distal end may be united laterally to a neighbouring tendon.

Dislocation of a tendon from its sheath or groove without fracture or other injury occasionally occurs from a sudden twist or strain. It is indicated by pain and partial or complete loss of function of the affected muscle, swelling and ecchymosis; whilst on examination the displaced tendon may sometimes be felt in its abnormal situation, or may be seen or felt, as in the case of the peroneus longus, to suddenly leave its groove and protrude in front of the malleolus during certain movements of the foot. The injury is most common about the ankle, and in the forearm, back, and neck. The *treatment* consists in replacing the tendon by manipulation, breaking down any adhesions that may have formed, and retaining it in place (which is often difficult) by a suitably applied pad and bandage, or in the case of ankle or wrist by a plaster-of-

Paris bandage, and subsequently by a leather support. In an obstinate case in which all mechanical measures had failed I succeeded in making a new sheath for the tendon by dissecting up a flap of periosteum from the fibula and sewing it over the tendon to the soft tissue at the back of its groove on the malleolus.

RUPTURE OF A TENDON may occur as the result of external violence or during some sudden and involuntary muscular action, and is very common in the plantaris and tendo Achillis, and somewhat less so in the biceps (see Injuries of the Upper and Lower Extremity). The tendon, except when the ends become widely separated, as generally happens in the case of rupture of the long tendon of the biceps, usually unites readily on the ends being approximated and kept at rest in that position.

EVULSION OR TEARING OUT OF A TENDON with a part of its muscle occasionally occurs, as the result of catching the finger or thumb in a machine, on a hook, &c. Part or the whole of a digit is usually torn off, bringing away with it the flexor tendon, this being more firmly attached to the bone than the extensor. In consequence of the tendon-sheath being thus left open suppuration is liable to extend along it into the forearm. Free drainage of the wound and antiseptic dressings are then imperative.

INJURIES OF ARTERIES.

CONTUSION OR BRUISING of an artery without laceration or other injury of its coats is of occasional occurrence, and is said to be followed by contraction and permanent diminution in the size of the vessel, and even by gangrene of the limb. Little that is definite, however, is known of this injury.

RUPTURE OR SUBCUTANEOUS LACERATION of an artery may occur as the result of any severe violence, but is perhaps most often due to the passage of a wheel over a limb, incautious attempts to reduce an old dislocation of the shoulder, and excessive violence in breaking down adhesions in stiff joints.

1. *The rupture may be partial*, *i.e.*, the internal and middle coats only may be torn. In such a case the external coat may subsequently yield to the pressure of the blood, thus laying the foundation of an aneurysm : or the internal and middle coats may be folded inwards into the interior of the vessel, obliterating its calibre, and in this way may cause, especially if the vein is also injured, gangrene of the limb (Fig. 57).

2. *The rupture may be complete*, *i.e.*, all the coats may be torn across. Here in a similar manner the artery may become occluded without any hæmorrhage ; or blood, often in enormous quantities, may be poured out into the tissues of the limb. In either case gangrene may ensue, especially if the vein is also ruptured and the injury

occurs in the lower extremity. Sometimes the extravasated blood, particularly in the upper extremity, may become encysted, a sac being formed for it by the inflammation and condensation of the surrounding tissues. This condition is called a *circumscribed* traumatic aneurysm in contradistinction to *diffused* traumatic aneurysm, the term sometimes applied to the injury when the blood is simply extravasated into the tissues, though in this latter case the name ruptured artery is more appropriate.

The *symptoms* vary according to the nature of the injury. When the main artery becomes occluded there will be pain at the seat of rupture and cessation of the pulse below, while later gangrene will probably, though not invariably, ensue. Should the artery not be occluded, blood in large quantities will escape into the tissues, giving rise to a rapidly increasing swelling, in which no pulsation can be detected, although a bruit may sometimes be heard; the limb becomes cold, and livid, and swollen, and the pulse, as a rule, can no longer be felt in the arteries below. When the extravasation is very large, constitutional symptoms of hæmorrhage will also be present, and signs of gangrene, if the ruptured artery is in the lower limb, will probably soon supervene, since not only is the main arterial supply cut off, but the collateral flow and venous return are also impeded by the pressure of the extravasated blood on the collateral arteries and veins. On the other hand, should the blood, as occasionally happens in the upper limb, become encysted, the swelling will slowly assume the characters of an ordinary aneurysm.

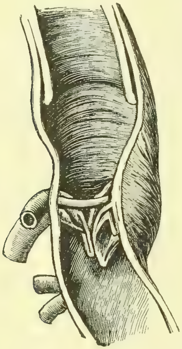


Fig. 57.—Obliteration of the subclavian artery by the infolding of the internal and middle coats without injury of the external coat.

Treatment.—(a) *When the artery is occluded* all that can be done is to endeavour to prevent gangrene occurring by maintaining the warmth of the limb till the collateral circulation has had time to become established. Should gangrene occur amputation must be performed as soon as a line of demarcation has formed. (b) *When blood in large quantities is extravasated into the tissues* the treatment will depend on the situation of the ruptured artery. Thus, in the case of the popliteal, amputation is usually called for, especially if the vein is also ruptured, as gangrene, for the reasons stated above, will almost invariably ensue if the main artery is tied either above or at the seat of rupture. In the case of the axillary, however, where the collateral circulation is much more free, the ruptured artery may be cut down upon and secured above and below the bleeding spot.

WOUNDS OF ARTERIES may be divided into the penetrating and the non-penetrating.

1. *The non-penetrating* are those in which either the outer only, or the outer and middle coats, are notched or torn. Here the wound may heal, or the uninjured coat or coats may ulcerate, or give way, and hæmorrhage ensue, or may gradually yield, as may also the cicatrix left on the healing of the wound, to the pressure of the blood, and lead to the formation of an aneurysm.

2. *The penetrating* are those in which the interior of the artery is laid open. In this case much will depend upon the size of the artery, and whether it is completely or only partially cut across, and upon the direction and size of the wound.

(a) *Wounds of large arteries*, as the aorta or pulmonary artery, whatever their nature, are usually immediately fatal.

(b) *Wounds of arteries of the second and third degree*, as the femoral and brachial. If the artery is *completely divided*, and the edges of the wound are cleanly cut, repeated hæmorrhages rapidly terminating in death will generally ensue; but if the edges are uneven and ragged, as in the avulsion of a limb by machinery or by a cannon ball, the external coat becomes twisted up, and the middle and internal coats retract and contract, a clot forms within the vessel, and no hæmorrhage occurs. If the artery is *partially divided* and the wound is made transversely to the long axis of the vessel, the longitudinal tension of the elastic coat causes the wound to assume a diamond shape, and severe hæmorrhage will ensue; but if the wound is made parallel to the long axis of the vessel, and is small (a mere puncture) it may heal by adhesive inflammation. In the latter instance the cicatrix may remain permanent, or it may subsequently yield, producing a traumatic aneurysm.

(c) *Wounds of medium-sized arteries*, as the radial and tibials, are attended, when the vessel is *completely and evenly divided*, by sharp hæmorrhage, followed by syncope, and temporary arrest from the formation of a clot. The artery may then become permanently occluded; usually, however, as the heart's power is restored the clot is washed away and hæmorrhage recurs. In this way hæmorrhages, alternating with temporary arrests, continue until death ensues from exhaustion. When the edges of the wound are *uneven*, or the artery is only *partially divided*, the effects are similar in each case to those described above in arteries of larger size.

(d) *Wounds of small arteries.*—If the artery is *completely divided* t will usually become occluded in the way described under Nature's

Method of arresting Hæmorrhage (p. 114); but if only *partially divided* such occlusion does not, as a rule, take place, and repeated hæmorrhages follow. Complete division will then often suffice to cause its occlusion, a plan which was frequently resorted to when bleeding from the temporal was practised.

When the wound through the soft tissues leading to a wounded artery is small or of a punctured character the superficial part of the wound may close, whilst the blood continues to be extravasated from the wounded vessel into the deeper part, where it may become encysted from the condensation of the soft tissues around (*circumscribed traumatic aneurysm*).

Treatment of wounded arteries.—1. When an artery is seen spouting in an open wound a ligature should at once be applied to the bleeding end. Other methods of securing the vessel, as torsion or acupressure, may of course be used if preferred; but as the ligature is almost invariably used at my own School, I shall, to prevent repetition of what has been already said under Arrest of Hæmorrhage (p. 116), speak of ligature only in the context.

2. When the end of a large artery is seen pulsating, but not bleeding in consequence of it having been *torn* across, I should, myself, apply a ligature to it as a precaution, though by some this would not be considered necessary.

3. When an artery is exposed for some distance in its continuity two ligatures had better, as a rule, be applied and the artery divided between them, especially if it be notched or bruised.

4. When an artery has ceased to bleed, even though the hæmorrhage may have been sharp, the wound should on no account be enlarged for the purpose of tying the bleeding vessel, unless it can be seen or felt; since not only may it not bleed again, but as the bleeding has ceased it may also be difficult or impossible to find it. In such a case, however, especially if the patient is much collapsed, he should be watched for the first sign of any return of the hæmorrhage, firm pressure in the meantime being applied over the wound, and where practicable over the course of the main artery above and below. The whole limb, moreover, should be carefully bandaged from below upwards.

5. When the hæmorrhage is moderate and clearly arterial, the external wound small, and the artery not seen, pressure should be applied in the way mentioned above, and will probably suffice.

6. When the bleeding is severe and evidently arterial, and the external wound is still open, whether the wound be deep, recent, inflamed, or sloughing, the well-established rule—to which, however, there are of course exceptions—is *to cut down upon the bleeding point and apply a ligature to each end of the artery if divided, or above and below the wound if the artery is punctured or only partially cut across.* To do this it is generally sufficient to enlarge the

wound in the soft tissues; but where the wound is on one side of the limb and the bleeding apparently comes from an artery on the other, a probe should be passed through the wound, its projecting point cut down upon, and the bleeding artery sought through this incision and tied as above. The object of this procedure is to prevent the necessity of making a very large wound.

The reasons for tying an artery at the place where it is wounded are:—1. It is often impossible to determine, without cutting down upon it, what artery is bleeding, and should the alternative plan of securing the main artery higher up be adopted, the wrong artery after all may be tied and the bleeding continue. Thus, for example, in a supposed wound of the femoral it might be the profunda, or even a small muscular branch, that was bleeding. 2. Even supposing the main trunk were the one wounded, the blood might still be carried by the collateral vessels into the artery beyond the ligature either above or below the wound in the vessel, and bleeding recur from either the proximal or distal end (Fig. 58). 3. Should, moreover, ligature of the main artery higher up thus fail to arrest the hæmorrhage, not only will the patient be further reduced by loss of blood, but the subsequent ligature, which will then probably in the end have to be applied to the bleeding artery in the wound, may through the extra interference with the collateral vessels induce gangrene of the limb. 4. Tying the main artery above is in itself in some cases a more dangerous and difficult procedure than enlarging the wound.

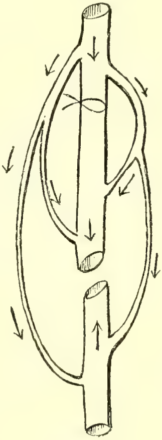


Fig. 58.—Diagram to illustrate the manner in which, after a ligature has been applied at a distance from a wound in an artery, the blood may be carried back again into the artery above and below the wounded spot by collateral vessels. The arrows indicate the direction of the blood current.

The reason for applying a ligature to both ends of the vessel if it is divided, or above and below the wound if it is merely punctured or only partially cut across, is that ligature of the proximal end only may be insufficient to arrest the hæmorrhage, since the blood, as seen in Fig. 58, may be carried round by the collateral channels into the artery below the wound and may thence escape by the open distal end.

Quite recently several successful cases have been reported in which a wound in an artery has been sutured, the stitches being so passed as to bring the endothelial surfaces into contact. Save in exceptional cases, this procedure seems to me to possess no special advantage, and might expose the patient not only to the risk of secondary hæmorrhage, but also to aneurysm from the yielding of the cicatrix.

In some instances the above rule of cutting down upon and tying the artery at the wounded spot cannot be carried out. Thus, where the artery is inaccessible, as in punctured wounds of the tonsil, or about the angle of the jaw where important structures would be damaged by enlarging the wound, it may be necessary to tie one of the carotids. Moreover, it may at times be safer to remove a limb than to search for the bleeding vessel, as for instance in wounds of the posterior tibial artery in the upper third of the leg, especially if the injury is complicated by fracture. Again, it may not only be found impracticable to ligature the artery at the wounded spot, but also impossible to tie or even compress the main vessel nearer the heart, as for instance in wounds of the subclavian above the clavicle. Here all that can probably be done is to trust to pressure firmly applied to the wound.

Whilst cutting down upon a bleeding artery hæmorrhage should be restrained by the use of an Esmarch's bandage, or by the tourniquet or the fingers applied to the main artery above the wound; and in the case of a wound of the external iliac or gluteal by Davy's lever passed up the rectum and made to compress the common iliac. Where it is impracticable to control the bleeding in any of these ways the wound, if necessary, should be sufficiently enlarged to admit one or two fingers, and the bleeding vessel, having been recognized by the escape of warm blood, should then be compressed by the finger, the wound further enlarged, and the artery secured with the aid of an assistant before the finger is removed from the bleeding spot.

Should gangrene ensue after ligature, and spread rapidly, amputation must be performed at the seat of ligature; but if it involves only one or two fingers or toes, or spreads slowly, a line of demarcation should be waited for before amputating.

TRAUMATIC ANEURYSM.—Two forms are described, the diffuse and the circumscribed.

The *diffuse* is practically a ruptured or wounded artery with extravasation of blood into the tissues. There is no attempt at the formation of a sac, and the term aneurysm applied to it is misleading. (See Ruptured Artery, p. 187.)

The *circumscribed* may be formed in several ways, as already stated under Rupture and Wounds of Arteries. Thus, 1. An artery may be wounded, pressure be applied, the external wound heal, and blood slowly escape into the tissues. 2. An artery may be wounded, heal, and the cicatrix subsequently yield. 3. An artery may without external wound be punctured by a fragment of fractured bone, or torn in reducing a dislocation, and blood in either case be extravasated into the tissues. 4. An artery may be wounded but not penetrated, and the uninjured coat or coats may yield to the pressure of the blood. In all of these cases the soft tissues around become condensed and form the sac of the aneurysm. Where the aneurysm is produced by the yielding of any portion of the arterial coat this at first will form the sac, but sooner or later it will give way, and the sac will then be formed by the condensation of the soft tissues around, as when the blood escapes directly into the tissues. The course, termination, and signs of a circumscribed traumatic aneurysm are similar to those of a spontaneous aneurysm. The *treatment*, however, inasmuch as the artery in the neighbourhood of the sac will probably be healthy, differs from the treatment of a spontaneous aneurysm in that the artery may be tied immediately above the sac, or the sac may be laid open and the vessel tied above and below. Recently traumatic aneurysms have been treated by extirpation. The sac is cut down upon, the artery on the proximal side tied in two places and divided, the sac dissected up intact, and the artery on the distal side secured. I have during the last few years treated three cases in this way. The wounds healed by the first intention.

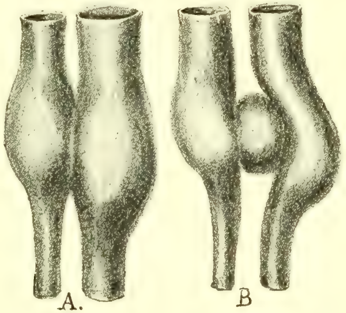


FIG. 59.—Diagram of arterio-venous aneurysm. A. Aneurysmal varix. B. Varicose aneurysm.

ARTERIO-VENOUS ANEURYSM is a pulsating tumour depending upon an abnormal communication of an artery with a vein. There are two kinds: in one the communication between the artery and vein is direct (Fig. 59, A), and the arterial blood is forced into the vein at each beat of the heart, causing its walls to be dilated into a fusiform or sac-like swelling (*aneurysmal varix*); in the other (Fig. 58, B), the blood first passes into a small aneurysm formed by condensation of the tissues between the artery and vein and thence into the vein, the dilatation of the vein being consequently less than in the preceding variety (*varicose aneurysm*). Both forms may occur spontaneously, but are usually the result of some injury, as a stab, wounding the walls of both vessels. The lesion was of common occurrence at the bend of the elbow when venesection was in vogue, the lancet passing through the median basilic vein and bicipital fascia into the subjacent brachial artery. *Signs.*—An aneurysmal varix gives rise to a pulsating tumour in which a peculiar bruit, compared to the buzzing of a fly in a paper box, is heard. The artery is dilated and thinned above owing to the impediment to the circulation, and is smaller below; whilst the vein is dilated, especially above, and pulsates. In varicose aneurysm, in addition to the above signs, which are common to both forms, an ordinary aneurysmal bruit can be heard. *Treatment.*—In aneurysmal varix some form of elastic support should be applied, or, if the swelling is increasing, the artery tied above and below its point of communication with the vein; or, better, the swelling may be cut down upon, and a ligature placed above and below the opening in both the artery and the vein and the intermediate portions of both vessels excised. In varicose aneurysm pressure may first be applied to the artery above the sac, combined with direct pressure on the sac. If this fails the artery must be tied above and below the sac, since if left to nature there is grave danger of rupture and hæmorrhage. When the carotid or the femoral artery and the adjoining veins are the subject of the lesion, no operative treatment as a rule should be undertaken unless the lesion is recent, and the blood as well as passing into the vein is being likewise extravasated into the tissues, and threatening to break through the external wound. In such a case, should pressure applied to the main artery and over the site of the wound fail, the artery must be cut down upon and tied above and below the wound. Unless pressure controls the hæmorrhage from the vein, a lateral ligature must be placed on the wound in its wall, or, if the wound is too large to admit of this being done, the whole vein may be tied above and below the wound, and then divided between the ligatures. In a case of this kind I successfully tied both the femoral artery and vein.

INJURIES OF VEINS.

Rupture or subcutaneous laceration of a vein occasionally occurs from causes similar to those producing rupture of an artery—an accident, moreover, with which it is frequently associated. When the vein is of large size much blood may be extravasated into the tissues, and may produce gangrene by pressure on the vessels carrying on the collateral circulation, though such a result is much less common than after rupture of an artery. The blood, except when the extravasation is large, is usually absorbed, but may break down and suppuration ensue.

Wounds.—Punctured and incised wounds when small and parallel to the long axis of even large veins readily heal by adhesive inflammation without obliteration of the lumen of the vessel. At times, however, a clot may form in the wound, and successive layers be deposited upon it until ultimately the vein is occluded. When a vein is completely cut across, as in amputations, it usually collapses as far as the next pair of valves, a clot forms as high as the first collateral branch, and the vein becomes permanently occluded in a way similar to that described under Healing of Wounded Arteries. In consequence, however, of the vein wall containing less elastic and muscular tissue than an artery, bleeding sometimes continues unless stopped artifically.

Treatment.—When the wound is a mere puncture in the continuity of the vein, unless it is found that pressure will control the haemorrhage, the coats should be nipped up by forceps and a lateral ligature applied so that the lumen of the vessel will not be obliterated. If a vein continues to bleed during an amputation it should be tied like an artery. A large wound, or one made in the longitudinal axis of a large vein, necessitates ligature of the vein in two places and the division of the vessel between the two ligatures.

The *dangers of wounds of veins* are:—(*a*) *Immediate*. 1. Haemorrhage. 2. Entrance of air. (*b*) *Remote*. These are complications depending chiefly on the size of the vein wounded and upon the septic or aseptic conditions attending the injury. They are:—1. Phlebitis. 2. Œdema. 3. Thrombosis. 4. Embolism. 5. Ulceration. 6. Metastatic abscesses in organs connected with the wounded vein. 7. Gangrene; and 8. Secondary haemorrhage.

Entrance of air into veins is fortunately a rare accident. It sometimes happens in operations about the root of the neck, where the disposition of the cervical fascia prevents the veins collapsing, and thus allows air to be sucked in during inspiration. Air is known to have entered a vein by the hissing sound during inspiration, the escape of frothy blood from the vein on expiration, the urgent dyspnœa, and the state of collapse into which the patient immediately falls. On listening over the heart a peculiar churning sound can be heard. Death in fatal cases usually occurs in a few minutes, and is due to the admixture of blood and air preventing the circulation through the capillaries of the lungs, and so causing distension and consequent inertia of the right side of the heart. *Treatment.*—The finger should at once be placed over the hole in the vein to prevent more air entering, and a clamp or ligature applied as soon as practicable. Pouring water into the wound has been suggested both as a means of preventing the further entrance of air during inspiration and of allowing that which is already in to bubble out during expiration. The patient should be placed with his head low to insure a sufficient supply of blood to the brain, and for the same purpose the arteries of the extremities should be compressed, whilst injections of ether or brandy should be given subcutaneously to stimulate the heart. Artificial respiration should not be performed till the vein is secured, lest more air be sucked in. To guard against the accident the veins should be clamped before division, and in removing a tumour traction should not be made at the moment the vein is severed. It has been proposed to puncture the right ventricle with a fine aspirating needle and suck out the contained air.

INJURIES OF NERVES.

WOUNDS OF NERVES.—A nerve may be completely or partially divided, and the wound may be of an incised, lacerated, contused, or punctured character.

Pathology.—After complete division of a nerve the divided ends slightly retract, and should union not be effected, either naturally or by surgical means, the portion of nerve below the injury, being cut off from its trophic centre, undergoes atrophy, and degenerates throughout its entire length (*Wallerian degeneration*). In the meanwhile the portion of nerve immediately above the wound is converted into a bulbous swelling by the proliferation of the fibrous tissue of the sheath and its prolongations within the nerve. The nerve-fibres within the bulbous end, being compressed by the newly-formed fibrous tissue, undergo atrophy and degeneration, but the rest of the nerve above the injury remains unimpaired. On microscopic examination of the bulbous end numerous young nerve-fibres are seen in the fibrous tissue (Bowlby). Should union, on the other hand, occur, the process by which it is effected is briefly as follows:—Inflammatory material is thrown out between the divided ends and forms a delicate fibrous network bridging the gap; into this the axis-cylinders of the upper end are said to grow out and unite with the degenerated axis-cylinders in the lower end, which then becomes gradually restored from above downwards. By some it is believed that new axis-cylinders "are developed from the nuclei of the sheath of Schwann in both the proximal and peripheral ends" (Bowlby). The exact manner, however, in which the union and regeneration of the nerve is brought about is hardly accurately known. When a nerve is only partially cut across, the divided portions may unite in the way above described, or they may become involved in the scar resulting on the healing of the soft tissues, and then prove a source of much irritation to the rest of the nerve.

The effects of wounds of nerves in addition to the degeneration of the portion below the wound are:—1. Paralysis of motion and sensation of the parts supplied by the nerve. 2. Subsequent wasting, atrophy, and fatty degeneration of the paralysed muscles. 3. Certain trophic changes in the tissues whose nutrition is presided over by the injured nerve, such as a glazed, smooth, cold, and bluish-red condition of the skin, falling off of the hair, cracking and deformity of the nails, local ulcerations and gangrene of the fingers, &c. 4. A marked diminution of the temperature of the part, which may be preceded for a few days or even a few weeks by a slight increase of two or three degrees. 5. Affections of the joints resembling rheumatism, and apt to terminate in more or less complete ankylosis. 6. Ascending neuritis, which is attended with severe pain in the cicatrix, pain shooting up the nerve, and pain in the area of its distribution, and 7. Very rarely, changes in the nerve-centres of a functional or of an organic nature.

Signs.—The immediate symptoms are loss of function in the parts supplied by the nerve, viz., muscular paralysis, local anæsthesia, or loss of special sense, according as a motor, sensory, or nerve of special sense is injured. In the case of a mixed nerve both motion and sensation will be lost; but sensation in some instances may be partially restored in a few days through anastomosing branches from other nerves. The remoter symptoms are wasting of the muscles, and the trophic changes of the skin, nails, &c., already alluded to, and sometimes pain in the cicatrix, and in the course of the nerve and its peripheral distribution. The muscles exhibit to electrical tests the *reaction of degeneration*, *i.e.*, they do not respond to the Faradic current, but contract on the application of a continuous current of less strength than that necessary to cause the contraction of normal muscles; the contraction elicited, moreover, is slow, long, and tetanic; and the sequence of polar reaction is altered ($ACC. > CCC.$ instead of $CCC. > ACC.$). Their response, however, to the continuous current becomes less and less till they finally cease to contract at all. As a consequence of the degeneration of the affected muscles their opponents undergo adaptive shortening, thus producing various deformities, as for example the hammer fingers (*main en griffe*) seen after division of the ulnar nerve, and the resulting paralysis of the interossei.

The *treatment* varies according as the wound of the nerve is recent or of long standing. In the former case the nerve should be sought in the wound, the divided ends sutured, the limb placed at rest on a splint in such a position that the united ends are not subjected to tension, and every effort subsequently made to obtain healing of the wound of the soft parts by the first intention. If the divided ends of the nerve are lacerated or contused, the injured portions should be cleanly cut away before applying the sutures. If the nerve is only partially divided the divided parts should be sutured. The sutures, consisting of fine China twist, should be passed with a small curved needle through the sheath of the nerve in four or five places. At St. Bartholomew's one of the sutures is generally passed completely through the nerve, a quarter of an inch from the divided ends, to ensure a better hold. In every recent wound it should be as much a matter of routine to suture large nerves, if divided, as to tie wounded arteries. If the nerve does not unite, an attempt may be made to procure union after the wound has healed, as may also be done in long-standing cases of non-union, though many months or even a year or two may have elapsed. An incision over the ununited ends should be made parallel to the nerve, the bulbous upper end of which can generally be felt through the soft tissues. The ends, which may have retracted so as to be as much as an inch or more apart, should be sought, the bulbous end shaved away little by little with a sharp scalpel till plenty of nerve-fibres are seen on the surface of the section, the lower end also refreshed, and the two united in the manner described above. Where the ends are embedded in much cicatricial tissue they should be freed by careful dissection, and when much separated stretched so as to bring them into apposition. If the nerve is only partially divided, and the divided portions are bound down by cicatricial tissue, the injured segment of nerve, in its entire thickness, should be cut away before applying the sutures. In some instances sensation may return within twenty-four hours of suture; but it may be more than a year in long-standing cases before the function of the nerve is restored. In the meanwhile the nutrition of the parts supplied by it should be promoted by warmth, and the muscles prevented as much as possible from degenerating by galvanism, massage, friction, and passive movements.

Transplantation of nerves or nerve-grafting.—The operation of nerve-grafting has now become a recognized surgical procedure. An attempt to restore the function of a nerve in this way may be made where the proximal and the distal ends cannot be brought into apposition, as, for instance, after a portion of nerve has been destroyed in a compound fracture, or after a portion of nerve, damaged by the contraction of cicatricial tissue, by the formation of callus, or by the growth of a tumour in its substance, has been removed. The graft may be taken from a freshly amputated limb or from a recently killed animal. This usually gives better results than the operation of splitting the nerve and turning the flaps into the gap. The conditions for success are :—Great care in dissecting out and handling the nerve, its immediate transference, the employment of a single suture at each end, the avoidance of all tension, strict asepsis, and immediate union of the wound of the soft parts. The interposed graft rapidly degenerates, but subsequent regeneration takes place if the above conditions are fulfilled.

SUBCUTANEOUS RUPTURE of a nerve is rare, but is occasionally met with as the result of a severe twist or wrench. I have seen it three times in the peroneal nerve where it winds round the head of the fibula. It is attended with severe pain at the time of injury, perhaps also referred to the periphery of the nerve, the gradual formation of a bulbous swelling on the nerve immediately above the rupture, and paralysis of motion and sensation in the parts supplied by the nerve. The same effects follow as in division of a nerve in an open wound. The *treatment* is also similar, In the evulsion of a limb the nerves may be torn away from their roots, as in the instance of a boy recently in St. Bartholomew's Hospital, whose leg was torn off above the knee, bringing with it the whole sciatic nerve as far as its origin from the spinal cord.

COMPRESSION of a nerve occasions numbness and tingling, and, if severe and prolonged, partial or complete paralysis of the parts supplied by it, and the series of changes described in the last section. As examples may be mentioned crutch palsy, due to the pressure of a crutch upon the large nerves in the axilla; the dropped wrist, from the involvement of the musculo-spiral nerve in the callus in fracture of the humerus; the tingling, numbness, and partial paralysis sometimes following dislocations of the shoulder, from the pressure of the head of the displaced bone on the brachial plexus; the pain caused by the pressure of a tumour on a nerve; the "pins and needles" felt in the feet after sitting on the edge of a chair, from compression of the sciatic nerve, &c. The *treatment* consists in releasing, if practicable, the nerve from the compressing agent. If a wound of the soft tissues is necessary to accomplish this object, healing without suppuration should be obtained, if possible, as otherwise the nerve may become again compressed by the resulting scar-tissue.

CONTUSIONS OF NERVES.—A familiar example of this injury is a blow on the ulnar nerve as it lies behind the internal condyle. There is intense pain at the spot struck, and shooting pains and "pins and needles" in the parts supplied by the nerve. These symptoms pass off shortly, but occasionally they may be more severe and last for several weeks, in which case there is probably some effusion of blood in the nerve. In rare instances ascending neuritis, persistent neuralgia, or even paralysis, and changes similar to those observed after complete division of a nerve, may follow.

FOREIGN BODIES IN NERVES.—A portion of a needle broken off in a nerve, the lodgment of small shot from a gun accident, &c., may give rise to inflammation of the nerve, persistent irritation and pain at the injured spot, spasm in the muscles, and pain or tingling in the parts supplied by the nerve. Such accidents have occasionally been followed by epileptiform convulsions. The *treatment* is to cut down upon and remove the foreign body.

SECTION IV.

Diseases of Special Tissues.

DISEASE OF BONE.

Diseases of bone may be classified into those depending upon—1. Inflammation and its results. 2. Simple defect or increase in nutrition. 3. Constitutional dyscrasia; and 4. New growths.

1. *Inflammation and its Results.*

Inflammation of bone.—In studying inflammation of bone it should be borne in mind that it is in the soft parts of bone—the periosteum, the medullary membrane, and the delicate vascular connective tissue which pervades the Haversian canals and cancelli that the inflammation occurs, and that the pathological process, though somewhat modified by the hard and resisting nature of the osseous framework, is essentially similar to that which occurs in the soft tissues. The same vascular and exudative changes ensue, and are accompanied by the like phenomena of redness, heat, pain, and swelling. The inflammation, moreover, may be of a simple and local, or of a diffuse and septic or infective character, and variously influenced by such constitutional states as syphilis, gout, and rheumatism, or by the presence of miliary tubercle. Further, it may terminate in resolution, or, in sclerosis, caries, necrosis, or suppuration, conditions comparable to fibroid thickening, ulceration, gangrene, and suppuration of soft parts. On account of the intimate connection of the bone with the periosteum and medullary membrane, inflammation is seldom limited to any of these structures, and when one is affected the others generally soon become also involved. According, however, as the inflammation begins in, or is chiefly confined to, the periosteum, medulla, or bone, the disease for convenience is spoken of as periostitis, osteo-myelitis, and osteitis.

Periostitis, or inflammation beginning in or chiefly affecting the periosteum, may be acute or chronic.

Acute periostitis may occur (1) as a simple local or (2) as a diffuse and infective inflammation, the former being generally the result of some local injury, the latter of some severe constitutional dyscrasia, or secondary infection, ACUTE SIMPLE PERIOSTITIS is generally the result of a local injury, and occurs most frequently in the tibia, that bone being most exposed to injuries, as kicks, blows, &c. *Pathology.*—The inflammation is of the ordinary simple kind, and usually terminates in resolution; occasionally, however, suppuration occurs, attended by some superficial necrosis, or the inflammation may become chronic. *Symptoms.*—There is acute throbbing pain, increased on pressure, and worse at night. If the bone is superficial, as in the case of the tibia, there may be also local redness of the skin, œdema, heat, and evident swelling over the bone, followed, should suppuration occur, by fluctuation. *Treatment.*—Rest, elevation of the part, and the application of cold, with perhaps a few leeches, will usually suffice; but should suppuration threaten, hot boracic poultices should be put on, and a free incision made as soon as pus has formed. Opium may be required to relieve pain.

DIFFUSE INFECTIVE PERIOSTITIS, sometimes known as "acute necrosis," is always of a grave nature, as not only may it lead to the death of large portions of bone, but it may also terminate fatally from septicæmia or pyæmia.

Cause.—It generally occurs in debilitated children following upon some slight injury, as a blow or fall upon the part. It is, however, probable that it depends upon some constitutional mischief, and that such local influences as injury, cold, &c., although they may act as slight exciting causes, have little or nothing to do with it. It also occurs as a sequela of the continued fevers, especially typhoid. From the constancy with which micro-organisms (*staphylococci*, *streptococci*) have been found in the pus, it is now almost universally believed to depend on their presence in the system. In inter- and post-typhoid suppurative periostitis the *Bacillus typhosus* has also of late been found in the pus, and is believed, either alone or in combination with the pyogenic cocci, to be the cause of the mischief. *Pathology.*—The disease is generally said to begin as an acute infective inflammation of the periosteum, which rapidly spreads through the bone to the medulla; but there is a growing belief that it begins in the medulla, and thence spreads to the periosteum. In any case pus is rapidly formed beneath the periosteum, and in the medulla and cancelli, and the bone thus cut off from its nutrient supply dies. Sometimes the whole diaphysis may in this way perish. The epiphyses, however, generally escape, as they are supplied by a separate set of vessels, which, as long as the epiphysial cartilage remains unossified, do not anastomose with those of the diaphysis. For the like reason the joints usually escape, but as the periosteum is continuous with their capsular ligament the inflammation may at times spread to them through this structure.

Symptoms and diagnosis.—The disease is attended with severe inflammatory fever, and is often preceded by a rigor, and sometimes accompanied by delirium. The shafts of the long bones are most frequently attacked, especially the lower end of the femur, the tibia, and the humerus. The nature of the local mischief may not at first be recognized, and the affection may be mistaken for acute rheumatism, but the deep-seated intense pain, which becomes agonizing on the least attempt at handling, soon makes it probable that the periosteum is affected. The soft parts covering the bone become swollen and œdematous, the skin white and waxy looking, and later dusky red, clearly indicating the presence of deep-seated suppuration. From abscess, however, it cannot always be diagnosed, except by an exploratory incision which will disclose bare bone. Should one of the neighbouring joints become involved the symptoms become more urgent, and the local signs of acute arthritis supervene. Signs of blood-poisoning now frequently manifest themselves, and the patient may rapidly succumb to septicæmia or pyæmia. Should recovery take place it is usually with the loss of considerable portions of bone, and after months of suffering, or it may be with a stiff joint or the loss of a limb.

Treatment.—Immediately the nature of the disease is discovered a free incision should be made to the bone under the strictest antiseptic precautions, and the wound dressed with sal alembroth gauze or similar antiseptic material. Many surgeons, believing the medulla to be primarily at fault, also expose with the chisel, saw, or trephine the medullary cavity, and scrape out the inflamed medulla. Where suppuration has occurred in the medulla, as shown by the escape of small beads of pus through the nutrient foramina, the medulla should certainly be exposed at the upper and lower limits of the periosteal denudation, the pus let out, and the cavity scraped and irrigated with perchloride of mercury (1 to 1,000). In this way the entire shaft of a long bone may be saved and the risk of pyæmia diminished. Abundant fluid nourishment and probably stimulants will be required, with large doses of quinine and injections of the anti-streptococcus serum should symptoms of blood-poisoning supervene. Should a joint become involved and suppurate it must be laid freely open and dressed antiseptically, whilst, should signs of sapræmia occur, the question of amputation must be raised. The necessity of an early incision cannot be too strongly insisted upon, as by its means extensive denudation of the bone and necrosis may frequently be averted and the risks of blood-poisoning greatly reduced. Should necrosis occur the dead bone will have to be removed when it has become loose. If the whole diaphysis is affected the dead shaft may be cut across, and the two ends twisted off at the epiphysis. I lately removed the whole diaphysis of the ulna in this way, with the result that all constitutional symptoms ceased at once, and the boy made an excellent recovery. If one end only is affected the bone may be cut across and the dead end removed. Extension should be applied till new bone has been formed from the periosteal sheath.

CHRONIC PERIOSTITIS is nearly always associated with some amount of inflammation of the subjacent bone, and is generally limited in extent, constituting what is commonly called a *node*. *Cause.*—It is mostly due to syphilis, but may be of rheumatic, tuberculous, or traumatic origin, or caused by the spread of inflammation from an ulcer of the soft parts. It sometimes occurs as a sequela of typhoid and other of the continued fevers. It then, in the case of typhoid, appears to depend upon the presence of the *Bacillus typhosus*. *Pathology.*—The periosteum becomes swollen and thickened from small-cell infiltration of its deeper layers, whilst a similar infiltration occurs in the Haversian canals of the contiguous bone. The inflammatory material may, under appropriate treatment, be absorbed; or it may undergo ossification, or more rarely break down into pus leading to caries or sometimes to necrosis of the subjacent bone. The ossifying variety (see Fig. 60), or the hard node (as it is called when circumscribed in extent), is more common in the long bones, the suppurating or soft node in the bones of the cranium. A suppurating node in the extremities is probably of tuberculous or typhoidal origin; a suppurating node on the cranium is generally syphilitic.

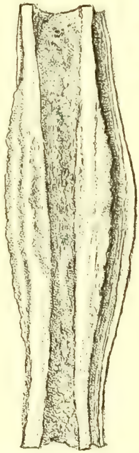


FIG. 60. — Chronic periostitis. (From St. Bartholomew's Hospital Museum.)

Symptoms and diagnosis.—The patient commonly complains of a deep-seated, dull, boring pain, worse by night than by day. On examination a hard, irregular swelling of the bone is felt, not as a rule very painful on handling, and not accompanied by redness of the skin. On the head the swelling is soft and fluctuating, and may have to be diagnosed from an abscess, new growth, or sebaceous cyst. Its evident connection with the bone, the history of syphilis or of typhoid, the effect of treatment, and if still in doubt, exploration with a grooved needle, will clear up the point.

Treatment.—Iodide of potassium is useful in all forms of chronic periostitis, but it may often be necessary to give it in large doses. In the syphilitic variety it generally acts like a charm. In the rheumatic an ointment containing iodide of potassium, mercury, and belladonna may also be used locally with benefit. In the tuberculous, cod-liver oil and syrup of the iodide of iron should be given. In all forms opium internally is indicated when there is much pain. The soft node on the cranium should on no account be opened, even where the skin is inflamed and appears about to give way, as iodide of potassium will then often promote complete resolution.

OSTEO-MYELITIS, or inflammation beginning in or chiefly affecting the medullary membrane and cancellous tissue of bone, may like periostitis be acute or chronic.

ACUTE OSTEO-MYELITIS may also occur as a *simple localized*, or as a *diffuse septic* or *infective inflammation.*

SIMPLE ACUTE OSTEO-MYELITIS is generally the result of an injury exposing the medulla as a compound fracture, or the sawing of a bone in amputation. In the latter instance it is usually quite local, though at times it may spread a slight distance up the bone and cause a *localized central necrosis.* The sequestrum in such a case has commonly a conical form, in consequence of the inflammation as it spreads up the medullary cavity, affecting less and less of the surrounding bone lamellæ. Beyond keeping the wound perfectly aseptic and removing the sequestrum when loose, no special treatment is required.

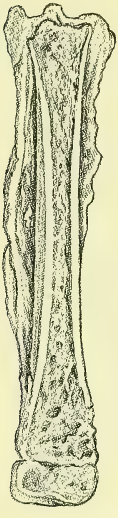


FIG. 61. — Acute osteo-myelitis of the tibia, with destruction of the knee and ankle joints. (St. Bartholomew's Hospital Museum.)

DIFFUSE INFECTIVE OR SEPTIC OSTEO-MYELITIS.—*Cause.*—This variety may be spontaneous or traumatic in origin. The former variety, like acute infective periostitis, usually occurs in young and debilitated or so-called strumous subjects without apparent cause, and also like it is generally believed to depend upon the presence of micro-organisms (*staphylococci*, *streptococci*) in the system. Indeed, as already stated, the disease described as infective periostitis is believed by some pathologists always to begin as an infective osteo-myelitis. It also occurs during or after an attack of typhoid fever, when the typhoid bacillus, which is always found in the bone marrow in fatal cases, may be the sole cause of the trouble. The typhoid bacillus may remain dormant in the marrow, and several months or even years after the febrile attack suddenly revive and set up an osteo-myelitis. The traumatic variety appears only to occur as the result of injury to the interior of bone, especially where the cancellous tissue is exposed, and where the wound is not kept aseptic. Hence it is most often met with after compound fracture, excisions, amputations, and the operation of trephining the skull.

Pathology.—Whether spontaneous or traumatic the inflammation rapidly spreads through the bone to the periosteum, and diffuse suppuration ensues, the danger of sapræmia, septicæmia, and pyæmia being even greater than in diffuse periostitis in consequence of the large patulous veins of the medulla becoming filled with purulent and either infective or septic thrombi. The spontaneous form would appear to depend upon the presence of infective micro-organisms (*staphylococci*, *streptococci*) in the system. Indeed, osteo-myelitis is the gravest staphylococcus infection with which the surgeon has to deal: here the *Staphylococcus aureus*, as Dr. Welch puts it, takes rank over the streptococcus, although there is no specific micro-organism of osteo-myelitis any more than there is of suppuration in general. The traumatic form usually depends on these micrococci introduced from without, and hence is probably preventable if the wound is kept strictly aseptic. Should the patient in either case not be carried off in a few days by sapræmia, septicæmia, or pyæmia, the whole diaphysis may die, or suppuration occur between the diaphysis and epiphyses, and destruction of the neighbouring joints ensue (Fig. 61). In less severe cases the medullary membrane may become thickened, and only the layers of bone immediately surrounding it may die (*central necrosis*).

The symptoms of the spontaneous form are similar to those of the acute infective periostitis (see p. 201), save that at first there may be less œdema and swelling of the soft parts; but soon the periosteum becomes involved, and then the one disease can hardly be distinguished from the other. The septic or traumatic variety is attended by high fever, rigors, and swelling and œdema of the limb, and a puffy tumour of the scalp when the diploë is involved. In the case of an amputation the wound looks unhealthy, the flaps separate, and the periosteum recedes, leaving the end of the bone exposed. A fungous mass of granulations generally protrudes from the medulla of the divided bone.

Treatment.—In the spontaneous variety an early and free incision through the periosteum to the bone should be at once made, if possible before pus has formed. In traumatic cases every effort should be directed towards rendering the wound aseptic, and ensuring an efficient drain. Of late considerable success has attended the scraping out of the inflamed medulla from the affected bone, and then insufflating the cavity with iodoform. The constitutional treatment should be similar to that described under *acute periostitis*. Should blood poisoning (*sapræmia*) threaten, the question of amputation must be raised. If this is decided on it should be done through the knee-, elbow-, or shoulder-joints, if the bones of the leg, forearm, or arm are involved, so as to avoid again cutting through cancellous bone. Amputation at the hip-joint is in itself so serious an operation that it is an open question whether it should be undertaken in the case of osteo-myelitis of the femur, or whether it would not be safer to amputate through the upper part of the femur and scrape out the medulla. When septicæmia or pyæmia is already fully established amputation should not be undertaken, but the effects of the anti-streptococcus serum should be tried.

CHRONIC OSTEO-MYELITIS can hardly be distinguished from chronic osteitis. Indeed, in chronic inflammation of bone the soft tissues lining the medulla, cancellous spaces, and Haversian canals are generally equally involved in the process, as is also frequently the periosteum. At times, however, the inflammation may be more or less limited to the medullary membrane, and to the layers of bone contiguous to it, and may then terminate either in central necrosis, or in ossification and the consequent obliteration of the medullary cavity (*osteo-sclerosis*).

OSTEITIS, or inflammation of the bone itself, is always associated with some amount of inflammation of the periosteum and of the medullary membrane, and hence it is often difficult in any given pathological specimen to determine whether it is one primarily of osteitis, periostitis, or osteo-myelitis. It may occur in any bone, or in any part of a bone, but is most frequent in the cancellous ends of the long bones, in the cancellated bones of the tarsus and carpus, and in the bodies of the vertebræ. The term osteitis as here employed refers to a chronic or subacute inflammation of bone, acute inflammation of bone being practically indistinguishable from acute osteo-myelitis or periostitis, under which it is included. The *causes* may be predisposing and exciting. Among the former may be mentioned syphilis, tubercle, typhoid, and rheumatism; among the latter, any local injury, and exposure to cold, damp, or malarial influences.

Pathology.—As in inflammation of soft parts, the first stage of osteitis is one of increased vascularity, the bone appearing red and injected from dilatation of the blood-vessels in the Haversian canals. Next, exudation and escape of leucocytes take place into the delicate connective tissue occupying the space between the blood-vessels and the bony walls of the Haversian canals and cancelli respectively, and the cells of the connective tissue itself also undergo proliferation. The earthy salts are loosened from their connection with the animal matter, and the bone lamellæ and trabeculæ are softened, eaten into as it were, and absorbed by the pressure of the inflammatory material, which here, as elsewhere, assumes the form of a small-cell-exudation (*granulation-tissue*). The bone is destroyed irregularly, appearing crescentically eaten out into spaces known as *Howship's lacunæ*, in each of which, and immediately in contact with the bone, are found large cells (*osteoclasts*) containing many nuclei. It is believed that these osteoclasts, which are in some way derived from the inflammatory exudation, take an important though unknown part in the absorption of the bone. The bone-corpuscles themselves are generally thought to be entirely passive, and to take no part in the rarefying process. In this way the Haversian canals and cancelli become dilated, the compact bone being thus converted into cancellous, and the cancellous further widened out (see Fig. 62). The periosteum and medullary membrane generally appear thickened. In inflammation of bone, as in inflammation of the soft tissues, several terminations may occur. Thus, *resolution* may take place, and the bone resume more or less its normal appearance; or the inflammatory material may undergo *ossification*, and the bone become hard and indurated (*osteo-sclerosis* or *osteoplastic osteitis*), a change comparable to that which occurs in the fibroid thickening of the soft tissues; or the rarefying process may continue until the affected portion of bone is completely destroyed by the granulation-tissue (*rarefying osteitis* or *caries*) a termination similar to ulceration; or if the inflammation is more acute, the vessels in the Haversian canals may become strangulated by the pressure of the inflammatory material, and the inflamed portion of bone may die (*necrosis*), a termination of like nature to gangrene of the soft tissues; or finally, the inflammatory material may break down into pus (*suppuration*), and an abscess be produced in a way similar to that which occurs in the soft parts.

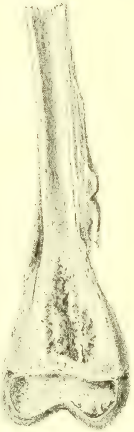


FIG. 62.—Rarefying osteitis. (St. Bartholomew's Hospital Museum.)

Signs and diagnosis.—The signs vary according to the intensity of the inflammation, and are similar to those of simple periostitis, and when, as is frequently the case, the osteitis is associated with inflammation of the periosteum the two can hardly be distinguished. There is deep-seated boring pain, worse at night and increased on exercise, perhaps some slight œdema, but seldom any redness unless the periosteum is involved, and then only when the bone is superficial. There is at first no swelling of the bone, though subsequently it may become perceptibly enlarged. The deep-seated character of the pain, its increase and long continuance after percussion of the bone, with, possibly, relief by steady pressure, and the absence of much, if of any, perceptible swelling, point to osteitis; whereas pain of a more superficial character and increased on pressure, together with an earlier appearance of swelling, indicates periostitis. From chronic abscess it is not always possible to diagnose osteitis, though in abscess the pain is generally more localized, and a slight yielding of the bone at one spot may be discovered.

Treatment.—Rest, elevation of the part, a few leeches in the more acute forms, the administration of iodide of potassium and in some instances mercury, the application of small blisters from time to time in the more chronic cases, and opiates internally with opium or belladonna liniments externally to relieve pain. In obstinate cases linear osteotomy, which consists in making an incision down to the inflamed bone, and continuing it into the bone substance by means of a Hey's saw or a chisel, will, by removing tension, generally give permanent relief and prevent further changes ensuing. Should the existence of an abscess be suspected the bone may be drilled in several directions or a small trephine applied. Where there is a taint of gout, struma or rheumatism, appropriate remedies for these affections must, of course, be given. In post-typhoid cases it may become necessary to expose and disinfect the medulla.

RAREFYING OSTEITIS, CARIES, OR ULCERATION OF BONE, is comparable to ulceration of the soft tissues, and is characterized by the rarefaction, molecular death, and loss of substance of the bone-tissue, and the tendency of the inflammatory exudation to caseous degeneration and suppuration.

Cause.—Tubercle and syphilis are undoubtedly the most frequent causes of caries. Sometimes, however, caries would appear to depend on a debilitated state of the system, in which there is no evidence of tubercle or syphilis, and to which the term struma may with propriety be applied. Occasionally it is the result of an injury.

Pathology.—Caries, as has already been stated, is one of the terminations of osteitis; indeed, it is often somewhat difficult to say where osteitis ends and caries begins. In caries the thinned and eroded trabeculæ of the inflamed bone become still further thinned and eroded by the action of the small-cell-exudation and osteoclasts until the affected portion of the bone is completely destroyed and replaced by granulation-tissue. Under appropriate treatment ossification of the granulation-tissue may occur; more often, however, especially in tuberculous cases, the inflammatory material undergoes caseation, and may break down into pus and an abscess be formed, which may remain as such in the interior of the bone or under the periosteum, or later may open externally, giving rise to a sinus leading to the disease. In other cases the small-cell-exudation undergoes further proliferation, and either makes its way to the surface of the bone (Fig. 63), and thence through the soft tissues and skin, or it perforates the articular cartilage and enters a joint (*fungating caries*). At other times the granulation-tissue merely destroys the bone without the production of pus (*dry caries* or *caries sicca*); whilst again the inflamed bone in the centre of the area may die *en masse* from the cutting-off of its blood supply, and become separated from the surrounding bone, forming a sequestrum at the centre of the carious spot (*caries necrotica*). In tuberculous cases giant-cells and the tubercle bacillus have been discovered in the inflammatory exudation. The favourite seat of caries is the cancellous tissue, whereas that of necrosis is the compact. Caries is most frequently met with in the bodies of the vertebræ, in the cancellous ends of the long bones, and in the short bones of the tarsus and carpus. The tuberculous variety, to which many restrict the term caries, is distinguished by the more marked tendency of the inflammatory material to undergo caseous changes; by the soft, greasy, crumbling condition of the bone; by the more extensive destruction of the bone; and by the little tendency shown towards the formation of new bone and repair.

The *symptoms* at first are those of local chronic osteitis and periostitis, namely some pain, with œdema and swelling of the soft parts over the inflamed bone; but soon the inflammatory products make their way to the surface, and a sinus or sinuses leading to the carious bone form. The sinuses have generally a button of œdematous granulations at their entrance, and a thin, purulent, and commonly foul-smelling discharge containing bone salts in solution escapes from them. On probing or on enlarging the sinus and introducing the finger, the bone is felt to be soft and friable, breaking down and readily bleeding. Caries of the vertebræ and of the articular ends of bone will be described under Diseases of the Spine and Joints respectively.

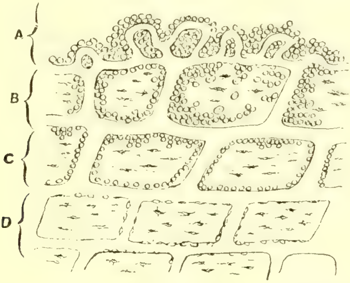


FIG. 63.—Diagram of caries. A. Granulation-tissue; B. Small-cell-exudation destroying the bone; C. Small-cell-exudation between vessels and walls of the Haversian canals; D. Normal bone.

The *treatment* will necessarily vary according to the situation of the disease. When accessible the carious bone may be gouged away. In doing this it will be known when all the carious bone is removed by the part becoming hard to the gouge. The sinuses should be well scraped with a Volkmann's spoon, and the wound dressed with iodoform-glycerine emulsion and iodoform gauze. Unfortunately, however, after the carious part has been removed the disease may recur in the surrounding bone, so that in caries of the tarsus or carpus it may be better to excise the whole of the affected bone or bones, or where the caries is extensive, to amputate the foot or hand.

NECROSIS is the death *en masse* of the whole or part of a bone, and is analogous to gangrene of soft parts. It is, however, of more frequent occurrence than gangrene, inasmuch as, owing to the hard and resisting nature of bone, the vessels are more liable to become compressed by the inflammatory effusion, and the blood-supply in consequence to be cut off. For the same reason necrosis is more common in compact than in cancellous bone; whilst the reverse holds good with regard to caries. Hence, moreover, necrosis is more frequent when the inflammation is acute, caries when it is less acute, as in the latter case the bone-trabeculæ slowly yield and disintegrate before the less quickly-produced inflammatory exudation, and the vessels consequently escape compression. The bones most often affected are the tibia, the femur, the lower jaw, the bones of the skull, and the phalanges of the fingers.

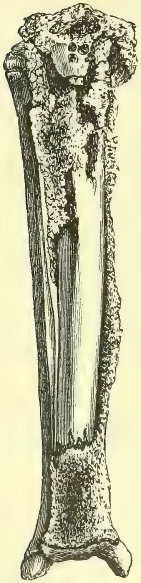


FIG. 64. — Necrosis of shaft of tibia. (Druitt's Surgery.)

Cause.—The immediate cause of necrosis, like gangrene, can in all cases be traced to the cutting off of the blood-supply of the bone, and this again may be due to inflammation, injury, or more rarely, as in the necrosis which sometimes occurs in old people, to some change in the vessels probably analogous to that producing senile gangrene of soft parts. The causes of inflammation of bone may, therefore, also be looked upon as causes of necrosis; but syphilis, the specific fevers, especially scarlatina, and mercurial and phosphorous poisoning, may be particularly mentioned.

Pathology.—In injury, the death of the bone is due to the stripping off of the periosteum, the destruction of the medullary membrane, or more rarely the plugging of the vessels in the Haversian canals with clots. In this way necrosis may occur after compound fracture, or in stumps after amputation; but the inflammation that follows the injury has no doubt also a share in its production. The way in which necrosis is brought about in inflammation has already been described under periostitis, osteitis, and osteo-myelitis, and according as it results from one or other of these causes will it vary in its situation and extent. Thus, when due to simple periostitis it is generally limited to the external lamellæ of the bone (*peripheral necrosis*); when to simple osteo-myelitis, to the layers immediately surrounding the medullary canal (*central necrosis*); when to diffuse, septic or infective periostitis or osteo-myelitis, it may affect the whole thickness of the shaft (Fig. 64), and possibly the whole diaphysis (*total necrosis*); whilst when due to osteitis it it is usually associated with caries, and only a portion of cancellous tissue perishes (*caries necrotica*).

Characters of dead bone.—The dead bone, which is called a sequestrum or an exfoliation, is bloodless, white, hard, dry and sonorous when struck, but often becomes brown or black when exposed to the air and the action of the discharges. Its free surface is smooth and even, or if previously inflamed, rough and irregular; its margins are serrated and ragged; and its previously attached surface is rough and uneven. It is heavy when sclerotic changes have occurred, light and porous when associated with caries.

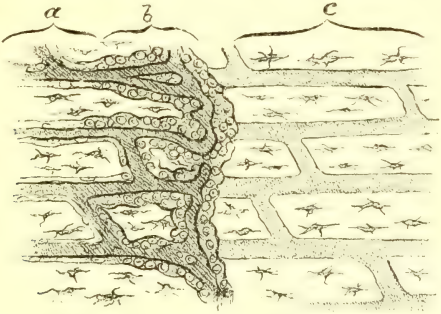


FIG. 65.—Diagram of the process of separation of dead bone. *c*. Dead bone; *b*. Inflamed living bone with formation of granulation-tissue where it is in contact with the dead part; *a*. healthy living bone.

Process of separation.—When a portion of bone has become necrosed it acts as a foreign body and nature tries to cast it off. In some situations she is successful, in others she fails, and if not assisted by art the dead bone may remain as a lifelong source of irritation. The separation of dead bone is best studied in superficial situations, as in the cranial bones (Fig. 66), where its process can be watched. Here, say, from the breaking down of a syphilitic node (*syphilitic periostitis*), a portion of bone is exposed and dies. This acting as an irritant causes the bone around to become inflamed (Fig. 65); rarefaction (*ulceration*) ensues, and around the dead portion is formed a groove, which gradually deepens and extends beneath the dead part until the latter is completely cut off from the living, and if not removed by art simply comes away, or *exfoliates*, as it is technically termed. The cavity left becomes filled with granulations, which subsequently ossify, and so restore the lost part. In situations, as in the tibia (Fig. 67), where the periosteum has not been destroyed, ossification of this membrane proceeds at the same time as the bone is being separated. The dead bone thus becomes surrounded on all sides by new bone, and lies bathed in pus in a cavity lined with granulations (Fig. 68), and though loose, is thus prevented from being cast off. It is then said to be *invaginated*, and is called a *sequestrum*. At certain spots where the periosteum and soft tissues have been perforated by the discharges from the inflamed bone making their way to the surface, ossification does not occur, and these apertures thus left in the casing of new bone are called *cloacæ* (Figs. 67, 68, 69, *d*). In necrosis of the popliteal surface of the femur, where the periosteum is very thin, and is merely in contact with the loose fat and cellular tissue of the popliteal space, the periosteum is usually destroyed and no osseous sheath is formed, the dead bone then lying in contact with the popliteal artery. In this situation, moreover, the necrosis is usually limited to the triangular popliteal surface of the bone, the firm attachment of the fibrous intermuscular septa to the ridges in the femur on each side of this surface preventing the further separation of the periosteum and consequent death of more bone. After the removal of the sequestrum the cavity (Fig. 69, *f*) fills with granulations, though more slowly than after the removal of an exfoliation.

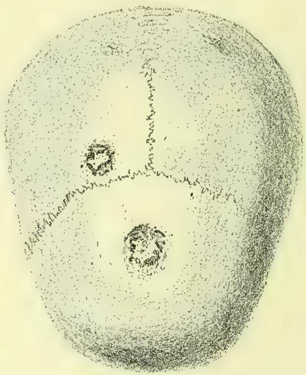


Fig. 66.—Syphilitic necrosis of the skull. (St. Bartholomew's Hospital Museum.)

Symptoms.—These vary according to the cause, stage and situation of the necrosis. When of inflammatory origin the symptoms at first will be those, already described, of periostitis, osteo-myelitis or osteitis, according as one or other of these has produced it. When suppuration has occurred and an incision has been made to the dead bone, or the discharges have made their way to the surface, or the wound, in the case of an injury, leading to the dead bone has remained open, a sinus or sinuses will exist. These generally discharge a thick foul-smelling pus, and are accompanied by much thickening of the bone, and redness and browniness in some instances of the surrounding skin. On passing a probe the dead bone will probably be felt. In traumatic cases there will further be the history of the injury. Having discovered dead bone the next point to ascertain is if it be loose. This may be done by observing if it can be moved by a probe, or, if two sinuses exist, by passing a probe down each and pressing alternately first in one, then in the other. If the sequestrum is loose, a see-saw movement may thus be given to it. In superficial situations such as the cranium, or where a bone protrudes or is exposed, as in a stump or compound fracture, the dead bone will at once be known by the characters already given (p. 211). *The chief distinctive signs*

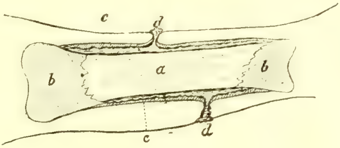


Fig. 67.

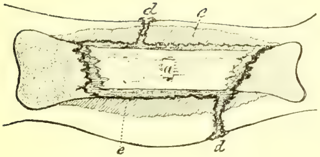


Fig. 68.

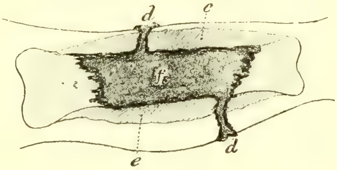


Fig. 69.

Figs. 67, 68, and 69 illustrate the formation of a sequestrum, its separation from the living bone, and the cavity left after its removal. *a.* Dead bone ; *b.* Living bone ; *c.* The separated periosteum lined by granulations ; *d.* Cloacæ lined by granulations, which are indicated by shading, and are continuous with those lining the cavity containing the sequestrum ; *e.* New periosteal bone perforated by cloacæ. *f.* Cavity left after removal of the dead bone. (After Billroth.)

between necrosis and caries are:—In necrosis the dead bone is generally hard and smooth, in caries soft, rough, and crumbling; in necrosis the granulations around the sinus are healthy and the skin is generally normal, in caries there may be no granulations, or if present they may be œdematous, and the skin around is undermined or inflamed; in necrosis the discharge is thick and yellow, in caries thin and watery; in necrosis there may be great thickening of the bone, in caries there is usually but little. It must not be forgotten, however, that caries may be associated with necrosis. In some cases of necrosis no suppuration occurs (*quiet necrosis*), but the bone becomes greatly swelled from the excessive formation of new bone around the dead portion. It then closely resembles a new growth, from which it may be impossible in some instances to distinguish it without an exploratory incision (see Tumours of Bone).

Treatment.—The dead bone should be removed as soon as it is loose. When it is superficial this can generally be done by the forceps, after slightly enlarging if necessary the sinus through the soft tissues, or where the end of the sequestrum is exposed in a stump by simply drawing it out. But where the dead bone is invaginated and the cloacæ leading to it are small, a more serious operation is required (*sequestrotomy*). The operation is much facilitated by the use of an Esmarch's bandage. The sinus leading to the most convenient cloaca should be enlarged by a simple incision in the longitudinal axis of the limb, the sequestrum seized by forceps, and if practicable drawn out. If the cloaca is too small to admit of this it must be enlarged, or two cloacæ, if present, may be laid into one by cutting away with a mallet and chisel, Hoffman's forceps, Hey's saw, gouge, &c., the intervening portion of the sheath of new bone. No more of the new bone, however, than is absolutely necessary should be cut away for fear of weakening the limb. For the same reason cloacæ should be enlarged in the longitudinal axis of the bone. The extraction of the sequestrum may often be aided by the use of the elevator, or by cutting it in two pieces with the bone-scissors. The cavity should then be sprinkled with iodoform, packed with iodoform or sal alembroth gauze to prevent bleeding, and the wound dressed with gauze impregnated with the same or other antiseptic material. Whilst the cavity is healing, which when large it may take many weeks or even months to do, the patient's strength must be supported by tonics and a generous diet. At times the sequestrum is so intimately interlocked between the old and the new bone that it may be impossible to remove it. In some situations, as the tibia, a flap of the new bone, with the overlying soft tissues, may be turned back by making a longitudinal incision with a cross cut at each end through the periosteum and bone. After the sequestrum has been removed the flap is replaced, a drain inserted, and the wound closed. The time required for the filling up of the cavity is much shortened by this method, which is known as *nécrotomie ostéoplastique*. In popliteal necrosis where there is no periosteal sheath and the dead bone is in contact with the popliteal artery, great care is required to prevent injury to that vessel. The incision for exposing the dead bone should be made either on the outer side of the popliteal space, or cautiously through the space a little to the outer side of the large vessels. In some cases, where the patient's powers are flagging from long-continued suppuration, or signs of lardaceous or other visceral disease are manifesting themselves, amputation may be called for.

SUPPURATION AND ABSCESS IN BONE.—Diffuse suppuration in bone has already been described as a common termination of diffuse osteo-myelitis and periostitis. Circumscribed suppuration or abscess is generally of the chronic variety, and, as already stated, is one of the terminations of chronic osteitis.

Chronic abscess in bone is most common in the cancellous ends of the long bones, especially the upper and lower end of the tibia and lower end of the femur, but is occasionally met with in other bones.

The *causes* especially leading to the termination of osteitis in abscess are thought to be the presence of tubercle or of other micro-organisms, the strumous diathesis, or a feeble state of health. At times the abscess can be apparently traced to an injury.

Pathology.—In the course of rarefying osteitis the bone-trabeculæ are gradually destroyed, and their place is taken by a small-cell-exudation, which now assumes the form of granulation-tissue. This in the focus of the inflamed spot softens and breaks down into pus, whilst that around the centrally-softened spot constitutes the abscess-wall, and forms to the naked eye a distinct membrane (Fig. 70) lining the bony cavity (*pyogenic membrane*). The bone around the abscess generally becomes sclerosed owing to the ossification of the inflammatory products, whilst new bone is formed beneath the periosteum. In this way as the abscess enlarges at the expense of the old bone, new bone is continually formed around, and hence the pus seldom makes its way to the surface as in the soft parts. As the abscess, however, approaches a joint new bone is not formed beneath the articular cartilage, and so the pus on reaching the cartilage may perforate it and escape into the joint. When the inflammation is more acute suppuration may occur before the bone-trabeculæ have been completely destroyed, under which circumstance a sequestrum of cancellous tissue may be found free in the abscess cavity (Fig. 71).

The *symptoms* are chronic, and often obscure. Generally there is pain of a dull, boring, and localized character, often intermittent, and worse at night; tenderness on pressure at the spot where the abscess is approaching the surface; some œdema and pitting of the soft tissues; occasional enlargement of the end of the bone; and later some dusky redness of the skin. Intermittent attacks of inflammation of a neighbouring joint without other apparent cause are very suggestive of abscess. These symptoms will usually serve to diagnose abscess from rheumatism, local periostitis, and a new growth in the end of the bone. From chronic osteitis it cannot always be distinguished; but this is not of so much importance as the treatment is practically the same. A skiagraph might possibly show the cavity in the bone.

Treatment.—An Esmarch's bandage having been applied, a crucial or ⊤-shaped incision should be made over the tender spot, and the bone trephined. If pus does not escape a perforator should be thrust in various directions into the cancellous tissue in the hope of discovering it. The abscess-cavity, after having been well scraped, should be mopped out with carbolic acid or chloride of zinc, and dusted with iodoform, and the wound dressed with iodoform or other antiseptic gauze, great care being taken to keep it aseptic. Should the abscess break into a joint amputation will probably be necessary.

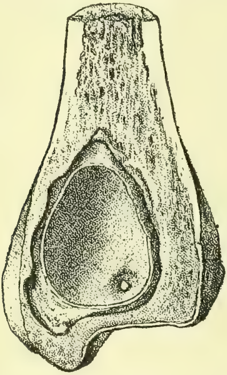


Fig. 70.—Abscess in end of tibia. The pyogenic membrane is well seen. (From St. Bartholomew's Hospital Museum.)

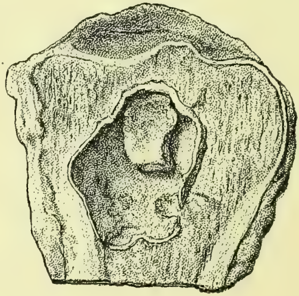


Fig. 71. — Necrosed cancellous bone in abscess cavity. (From St. Bartholomew's Hospital Museum.)

2. *Diseases depending upon Simple Defect or Increase in Nutrition of Bone.*

Under this head are included two diseases of bone in which neither inflammation nor such constitutional affections as syphilis or struma appear to take part—Atrophy and Hypertrophy.

ATROPHY of bone is a common accompaniment of old age. It may also be produced by pressure and disuse. Thus it is seen in the bodies of the vertebræ from the pressure of an aneurysm of the aorta or a tumour in the mediastinum; in the bones of a limb from disuse, as in long-continued joint-disease, and in stumps after amputation. An atrophied bone is always decreased in weight, often in size; and in some situations, as the neck of the femur, is liable to fracture on slight provocation. Atrophy is always attended with more or less fatty degeneration.

HYPERTROPHY of bone is an overgrowth of bone which is due merely to an increase of nutrition and not to any inflammatory change. It is generally dependent upon excessive functional activity of the part, the bone increasing in size and strength commensurately with the hypertrophy of the muscles. It may also occur in association with general hypertrophy of the tissues in the affection known as congenital hypertrophy. It must be distinguished from inflammatory thickening of bone, a condition to which the term "hypertrophy" is sometimes, though incorrectly, applied.

3. *Constitutional Affections of Bone.*

Under this head are included Syphilitic and Tuberculous affections of bone, Rickets, Scurvy-rickets, Mollities Ossium and Acromegaly.

SYPHILITIC AFFECTIONS OF BONE are common both in acquired and congenital syphilis. In the former they generally occur during the tertiary stages of the affection, either as gummatous inflammations of the periosteum (nodes), or as chronic inflammatory thickenings or gummatous infiltrations of the bone itself, leading to caries, necrosis, or sclerosis. For a full account of the peculiarities in the above affections when due to syphilis the student is referred to a work on Pathology. The affections of the bones in *congenital syphilis* have already been briefly referred to in the section on that subject (see p. 60).

TUBERCLE.—We have already seen that many of the inflammatory diseases of bone, especially some forms of rarefying osteitis or caries, are attributed to the presence and degeneration of tubercle; and it has been pointed out in what respects the affections of tuberculous origin differ from those of a simple or traumatic nature. Here it need only be added that miliary tubercles may often be found scattered through the medulla and in the cancellous tissue in cases of acute tuberculosis; but as in these cases the bone-affection plays but a secondary part and cannot be diagnosed during life, nor indeed as a rule gives rise to any symptoms, it need not be further described.

RICKETS, though generally described under Diseases of Bone, is a constitutional affection occurring in infancy and early childhood.

It is characterized by impaired nutrition and arrest of development of the whole body, and especially by the softening and the resulting deformity of the bones.

Causes.—(1) Malnutrition produced by improper food, especially an excess of the starchy elements during infancy; (2) debility of the mother during gestation and lactation as the result of excessive child-bearing or over-suckling; and (3) bad hygiene, *i.e.*, want of fresh air and sunshine, residence in damp dwellings, uncleanliness, and lack of attention generally. Tubercle and syphilis in the parent, but I think without sufficient evidence, are also given by some as causes.

Pathology.—The bone changes consist essentially in the formation of soft, vascular, imperfectly-ossified bone, which replaces the healthy bone as the latter is gradually absorbed in the normal process of development. This ill-formed bone is produced both at the line of the epiphysis and under the periosteum, *i.e.*, in those situations where active growth normally occurs. In the former situation the intermediate semi-transparent bluish zone of ossifying cartilage between the diaphysis and epiphysis is greatly increased in thickness and its line of junction with the bone is no longer straight but broken, in consequence of the irregular advance of ossification. The adjacent bone is soft and spongy, and contains here and there islets of cartilage which have escaped ossification, whilst its medulla is abnormally vascular. It is to the excessive formation of this proliferating layer of cartilage and ill-formed bone immediately underlying it that the enlargement of the ends of the long bones and the beading of the ribs (Fig. 73) so characteristic of rickets is due. Microscopically the cartilage-cells in the bluish zone are seen enlarged, and instead of being arranged in regular columns are grouped irregularly; whilst the calcification of the matrix between them is also seen proceeding in an irregular manner, so that calcified or ossified patches exist here and there where all should be cartilage, and portions of cartilage where all should be bone. The vascular medullary spaces which are continuous with these channels in the shaft likewise project in an irregular manner into the cartilage, and the laminæ of bone formed from the osteoblasts lining these spaces are deficient in earthy salts. Under the periosteum, the superficial layers of which are unaffected, similar soft bone is laid down in consequence of the osteoblastic layer,

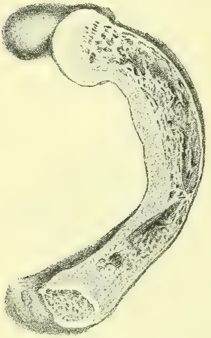


Fig. 72.—A longitudinal section of a rickety femur. (St. Bartholomew's Hospital Museum.)

though increased in thickness, producing osteogenetic fibres deficient in earthy salts. Hence, whilst all the bones are more or less softened, the long bones become swollen at their ends, and the flat bones thickened especially along their line of suture. The liver, spleen, and lymphatic glands are often enlarged from irregular increase of their fibrous elements, and the muscles are generally soft, flabby, and wasted.

Symptoms.—Rickets is most frequently met with between the ages of eighteen months and two and a half years. Among the early symptoms may be noticed sweating of the forehead and perhaps of the upper part of the body, throwing off of the bedclothes from a desire of the child to be cool, a general restlessness, and often an excessive tenderness on handling and aversion to movement. Sometimes large quantities of phosphate of lime are found in the urine. The abdomen is generally enlarged, and there is frequently some gastric catarrh and flatulence. The swelling of the ends of the long bones, especially of the lower end of the radius and tibia, the beading of the ribs where they join the cartilages (Fig. 73), and the thickening of the cranial bones along their line of suture are characteristic of the disease. Later, bending of the bones occurs.

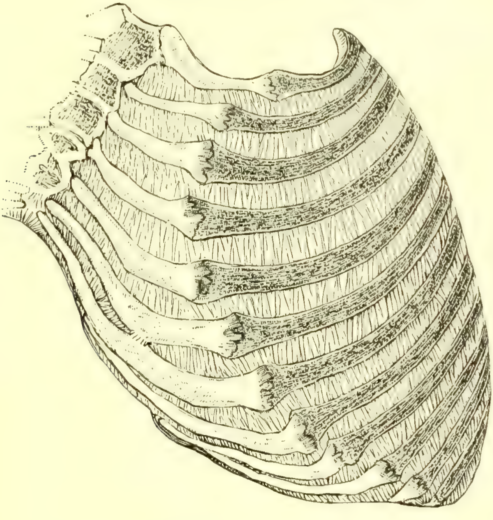


FIG. 73.—The whole of one side of the chest from a rickety child showing the "beading" of the ribs at their costo-chondral joint. (*The rickety rosary.*) The ribs are less curved than normal, and the sterum is pushed forward. (St. Bartholomew's Hospital Museum, No. 270 *a.*)

Thus, the long bones generally give in the direction of their norma curves and near the epiphyses, leading to knock-knee, bow-legs, and other deformities. The yielding of the ribs to atmospheric pressure produces the deformity known as pigeon-breast. The spine presents a general curvature with the convexity backwards in infants and young children, and in older children a lateral or a lordotic curve. The pelvis is ill developed, flattened and usually of a reniform or hour-glass shape in consequence of the depression of the promontory of the sacrum. The head is square, the forehead prominent, and the fontanelles are late in closing. The occipital bone is sometimes thinned so that it yields on pressure, or it may be in places absorbed, a condition known as *craniotabes.* By some pathologists, however, this condition is believed to be due to congenital syphilis. Dentition is generally delayed, or the teeth, if cut, often soon decay and fall out. Bronchitis, diarrhœa, convulsions, laryngismus stridulus and chronic hydrocephalus are not infrequent complications; and to any of these, but especially to the first two, the child may succumb. Under appropriate treatment the disease is nearly always arrested, and perfect recovery results. The bones, however, if much bent are liable to become consolidated in their deformed condition and premature synostosis of the diaphysis and epiphysis is apt to occur, inducing a stunted growth. The bones are also harder and denser than natural, especially on the side of their concavity, where a thick buttress-like layer of dense hard bone is formed (see Fig. 72). Similar changes sometimes occur in older children usually between the ages of nine and thirteen, and are then spoken of as *late rickets.* It is believed by some that when rickety changes occur thus late, they are merely a recrudescence of the disease which in early life had been overlooked (Makins).

The *treatment* resolves itself into proper feeding and correcting bad hygienic conditions. The child should have plenty of new milk and cream; and the juice of raw or underdone meat, or underdone meat that has been pounded up, should be given in quantities suited to the age and powers of assimilation. Farinaceous food should be restricted in amount, and in the case of infants forbidden. Abundance of fresh air and sunlight and attention to cleanliness are especially indicated. In the way of medicine cod-liver oil is the most important, and may almost be looked upon as a specific. It should be combined with syrup of the phosphate or lacto-phosphate of iron and lime in half-drachm to drachm doses. The deformity of the legs may be corrected in the earlier stages by insisting upon the child not being allowed to stand or walk. To ensure its being kept off its legs, splints reaching from the waist to below the feet may be applied. Confirmed deformities can only be dealt with by instruments or operation, which will be described under bow-legs, knock-knee, osteoclasia, osteotomy, &c.

SCURVY RICKETS is an acute affection of young children. It is also known as *acute rickets* and as *infantile scurvy.* The disease is characterized by the ordinary changes of rickets with the addition of sudden swellings in connection with the bones, and especially with the femur. The swellings are due to extravasation of blood beneath the periosteum. The chief *signs* are acute tenderness, œdema of the limb, and generally a spongy condition of the gums. The *treatment* consists in rest and in the use of such constitutional remedies as are appropriate for both scurvy and rickets.

OSTEO-MALACIA OR MOLLITIES OSSIUM is a rare disease characterized by softening of the bones through the re-absorption of their earthy salts and destruction of their osseous lamellæ.

Cause.—It is a disease of adult life, and most often occurs in females during the child-bearing period. Sometimes it appears to be hereditary; but its causation is practically unknown.

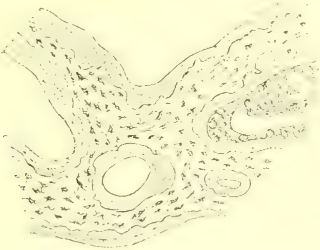


FIG. 74.—Microscopical appearance of a fragment of bone in mollities ossium. (From Rindfleisch.)

Pathology.—The disease appears to begin in the medullary tissue of bone which is replaced by a soft, dark red gelatinous material somewhat resembling spleen-pulp, whilst later the whole bone, with the exception of a thin layer immediately beneath the periosteum, becomes replaced by this material and reduced to little more than a mere shell. The bone appears first to become decalcified and then destroyed. The exact pathology of the process is not known, but it has been suggested that the decalcification of the bone is due to the action of lactic acid, which has been found both in the bone and the urine, or to excess of carbonic acid in the veins of the medulla, 2 which are said in the early stages to be enlarged. The microscopical appearances lend some support to this view, as in a bone-trabecula (see Fig. 74) the decalcification is seen to begin around the Haversian canals and medullary spaces, the bone-corpuscles in these parts having entirely disappeared while in the centre of the trabecula they are still present. At times the gelatinous material is in places yellow and fatty-looking. In some of the specimens in St. Bartholomew's Hospital Museum the medulla appears entirely filled with fatty material, but it is a question whether these specimens, though called mollities ossium, are not of a different nature from the disease to which the term is generally applied, and do not rather depend upon a senile change.

Symptoms.—In the early stages the disease may be mistaken for rheumatism or neuralgia, as, beyond some general feeling of weakness with obscure pains in the bones, it is attended with no definite symptoms. Suddenly, however, fracture of some bone occurs, whilst others become bent and variously distorted without any or with but the slightest provocation. Thus the pelvis, thorax, spine, and extremities become misshapen and sometimes extraordinarily deformed. The pelvis is flattened from side to side, the symphysis pubis projects in the form of a beak giving a rostrated appearance to the pelvic inlet, whilst the tuberosities are approximated and the pubic arch is diminished in width. Thus, parturition is rendered difficult if not impossible. The condition of the urine is an important element in the diagnosis, a peculiar form of albumen and abnormal quantities of phosphates and lactic acid being found in it. The disease progresses and the patient generally dies of exhaustion, or during parturition, or of dyspnœa consequent upon respiratory trouble induced by the weakened ribs. In a few cases recovery has taken place.

Treatment.—No remedy is at present known for the disease. The strength must be supported by tonics and abundance of nourishing food, pain must be relieved by opium, and rest enjoined in order to prevent fracture. The patient should be warned of the danger of child-bearing. Should she be already pregnant, the question of inducing premature labour must be raised; whilst, should she be at her full time, craniotomy, or in advanced deformity of the pelvis, Cæsarean section, may be necessary. In a large number of cases of late, especially in the districts on the Continent where the disease is prevalent, oöphorectomy has arrested the disease and the bones have again become firm.

Acromegaly.—This disease is characterized by a symmetrical enlargement of the bones of the hands and feet as well as those of the head and face, the nasal and inferior maxilla being chiefly affected. The disease is supposed to be associated with changes in the pituitary body, but at the best is at present little understood. Pain in the extremities, nervous irritability, persistent headache, progressive loss of sight, loss of muscular strength, and gradual bending of the back are some of the chief symptoms. Thyroid extract has done some good in relieving the headache and pain and nerve symptoms.

Achondroplasia is a rare and peculiar condition of the bones somewhat resembling rickets in that the ends of the long bones are enlarged at the epiphysial lines. The disease is congenital, and usually leads to the death of the fœtus. If the child is born alive it grows up as a dwarf on account of the thickened and stunted condition of the bones of the arms and legs. The tibiæ may be bent and knock-knee present as in rickets. The spinal column, skin, hair, and sexual organs are natural, and the mental condition good. The fingers show a peculiar enlargement at the joints. I recently had under my care three children in one family affected in this way. The condition must not be confounded with fœtal rickets or cretinism.

4. *New Growths in Bone.*

NEW GROWTHS.—Nearly all the varieties of tumour described in the section on that subject (p. 62) occur in bone. Some, indeed, as the exostoses, are altogether confined to the bony tissue; others occur in it so frequently that it may be said to be their favourite seat; others, again, are in this situation so rare that they may be dismissed as pathological curiosities. Some, moreover, the carcinomata, only occur in bone as secondary growths, the primary malignant tumours of bone, formerly described as carcinomata, being now classed as sarcomata.

Tumours of bone may spring from the periosteum, the medulla, or the bone itself, and exhibit a remarkable tendency to undergo calcification or ossification, and when of slow growth to assume the character of true bone.

OSTEOMATA OR OSSEOUS TUMOURS have the structure of true bone, and are only met with in connection with bone. They must be distinguished from other forms of tumour that have undergone calcification or ossification. They may be divided into the circumscribed and the diffuse.

Circumscribed osseous tumours or exostoses occur in two chief forms, the cancellous and the compact.

(*a*) *The cancellous or spongy exostoses* consist of cancellous bone containing marrow in its cancellous spaces, and surrounded by a delicate layer of compact bone, which itself is covered with a capping of cartilage, or sometimes merely with periosteum. They are most frequently met with in the young, and are considered by some to be ossifying enchondromata and to spring from portions of the epiphysial cartilage that has escaped ossification. Their common situation is at the junction of the diaphysis and epiphysis of long bones, or at the origin or insertion of muscles—as for example, the insertion of the adductor magnus into the tubercle just above the internal condyle of the femur, and the pectoralis major into the external bicipital ridge of the humerus. They are also very common on the last phalanx of the great toe.

(*b*) *The compact or ivory exostoses* consist of dense, hard bone, which usually contains no Haversian canals. They nearly always spring from the bones of the skull and face, and are generally sessile or broadly pedunculated, and of a lenticular shape.

Symptoms.—The cancellous variety are met with as hard, smooth or irregular, and frequently pedunculated tumours of slow growth, and are commonly of small or moderate dimensions. Sometimes they are quite painless, but at other times they cause pain on movement or pressure, as is the case with the small exostosis which so frequently grows from the distal end of the dorsal surface of the last phalanx of the great toe. This, which is usually harder than the more common form of cancellous exostosis, but less hard than the ivory, occurs as a tumour projecting under the nail, and raising it up as it grows. In some cases exostoses affect simultaneously many bones, and at times nearly all the bones of the body. They are then generally hereditary, and often symmetrical, and are spoken of as *multiple exostoses.* They have the structure of the cancellous form. The evident firm attachment of the ivory exostoses of the skull to the bone, their slow growth, small size, great hardness, the freedom with which the scalp grows over them and the absence of pain and history of fracture or other injury, sufficiently serve to distinguish them.

Treatment.—A spongy exostosis, unless occasioning pain, deformity, or other inconvenience, or growing rapidly, may be left alone; otherwise, it should be removed by a chisel, bone-nippers, saw, &c., taking care it is completely extirpated, as what is left will have a tendency to grow again. In removing an exostosis from near the knee-joint, the synovial membrane may be avoided by flexing the knee, and so drawing the membrane away. Ivory exostoses should not as a rule be interfered with, as they are so hard that no ordinary saw will cut through them, and the skull has been fractured in attempts to remove them with the chisel. If causing great inconvenience, however, it is probable that they might be safely removed by the rapidly revolving saw of the surgical engine.

Diffuse osseous tumours occur in connection with the bones of the face, often filling up the antrum, occluding the nasal chambers, and producing much deformity. They are composed of finely-cancellated bone, and are more compact than the cancellous exostoses, but less compact than the ivory. Their slow growth, extreme and uniform hardness, and irregular nodulated surface will serve to distinguish them from sarcomata undergoing ossification. There is usually little or nothing that can be done in the way of treatment. The superior maxillary bone, however, has at times been removed when the growth has been confined to it alone.

ENCHONDROMATA OR CARTILAGINOUS TUMOURS.—The general and microscopical characters of these growths have already been described under Tumours (p. 68). In the bones they are most frequently met with in the fingers (Fig. 75) and in the ends of the long bones. In the fingers, where they are generally multiple and often congenital, they usually begin in the interior of the ends of the phalanges or metacarpal bones, and as they increase in size, expand the bone around them into a thin shell, which may finally give way, allowing them to protrude. When growing from the articular ends of long bones, they generally spring from the periosteum, and thence grow both outwards and inwards, but seldom involve the articular surface. They are thought by some to possibly arise from the epiphysial cartilage, especially as they are most often met with in the young. They should not be confounded with sarcomata, in which considerable masses of cartilage are frequently developed, or with the exostoses, which are often capped with cartilage and are regarded by some as ossifying enchondromata. The enchondromata rarely ossify, but may undergo calcification or mucoid softening, and when unmixed with sarcomatous elements are quite innocent.

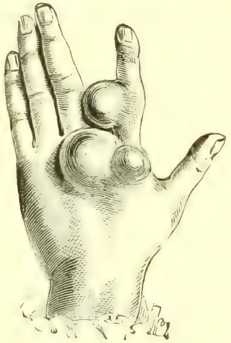


Fig. 75.—Cartilaginous tumours of the bones of the hand. (From Druitt's Surgery.)

Symptoms.—Their slow growth, great hardness, evident attachment to the bone, the absence of glandular enlargement, and non-implication of the surrounding tissues and skin will serve for their diagnosis. When of large size ulceration of the integuments covering them may be produced by their pressure.

Treatment.—If small, and involving, say, only one finger, they may be enucleated, taking care not to injure the neighbouring joint. But when several fingers are implicated, and the hand is rendered useless, amputation of the affected fingers, or of the whole hand, may be necessary. The removal of the limb is usually called for when they grow about the articular end of a long bone, especially if they have attained a large size.

Fibromata or fibrous tumours seldom occur in bone except in the jaws or in connection with the base of the skull. They then constitute the common form of epulis and naso-pharyngeal polypus respectively, and are described under Diseases of the Jaws and Nose.

Lipomata or fatty tumours too rarely occur in bone to require special mention. I have seen one or two growing from the outer surface of the periosteum (*parosteal lipoma*). They were not diagnosed before operation.

SARCOMATA in bone may be divided into the periosteal and the endosteal, the former being commonly of the round-celled, spindle-celled, or mixed variety, the latter of the myeloid variety. The *periosteal* (Fig. 76) spring from the deep layers of the periosteum, and as they increase in size invade the bone beneath on the one hand, and the soft tissues surrounding them on the other, till finally the skin is involved, and they protrude as a fungous mass if the patient has not been already carried off by the dissemination of the growth through internal organs. They are very prone to calcification and ossification, and are then spoken of as ossifying sarcomata. Their favourite situations are the neighbourhood of the large joints, which, however, they seldom involve. Though not usually implicating the lymphatic glands, they often rapidly infect the system through the blood-stream and quickly return after removal. The *endosteal* or central spring from the medulla in the interior of the bone, and are of slower growth and generally less malignant than the periosteal. As they increase in size they expand the bone around them into a thin shell (Fig. 77) which finally gives way, when they grow with greater rapidity, behaving as the periosteal variety. The giant-celled or so-called myeloid form of the endosteal sarcoma is less malignant, and may not return after enucleation or complete removal for several or many years, and possibly not at all. Mr. F. E. A. Colby, who has looked through the record of myeloid sarcomata removed at St. Bartholomew's, has not found a single case of recurrence. A variety called *parosteal*, in which the sarcoma involves the outer layers only of the periosteum, has been described.

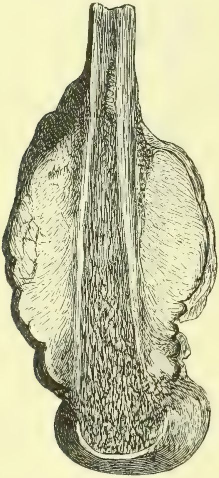


FIG. 76.—Periosteal sarcoma of femur. (St. Bartholomew's Hospital Museum.)

Symptoms.—In a typical case of *periosteal sarcoma* there will be a rapidly growing tumour, evidently connected with the bone, not as a rule painful, nor usually attended with heat, œdema, redness, or increase of body temperature. The swelling is soft and semi-fluctuating or boggy, sometimes indistinguishable by touch from an abscess; or hard in some parts, soft in others; or, if ossifying, uniformly hard all over. The superficial veins may be tortuous and dilated, and the neighbouring lymphatic glands enlarged. The patient, who is usually young, frequently complains of having lost both weight and strength, although till later there may be no cachexia. Often there is a distinct history of the tumour having appeared some time after an injury of the part, and it is probable in some cases such may be the cause of the growth. The *endosteal* are of much slower growth, and are generally accompanied by boring pain whilst the bone is being expanded. Sooner or later they give rise to a more or less uniform swelling, generally of the articular end of one of the long bones, and as the shell of bone becomes thinned a peculiar sensation, known as egg-shell crackling, may sometimes be felt on palpation. After they have protruded from the bone they present similar signs to the periosteal, and at times distinctly pulsate, especially when connected with the pelvic bones. They may then be mistaken for an aneurysm.

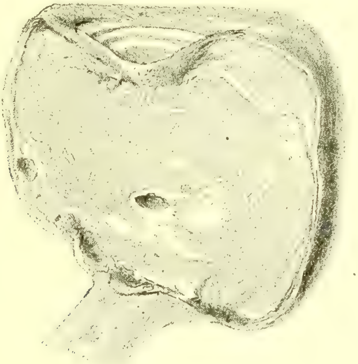


Fig. 77.—Endosteal sarcoma in head of tibia. (St. Bartholomew's Hospital Museum.)

Diagnosis.—The above signs will commonly serve to distinguish a sarcoma from an innocent tumour of bone. From an inflammatory affection, such as subacute periostitis or osteitis, quiet necrosis, or an abscess in the interior of the bone, it is sometimes very difficult to diagnose a sarcoma. The absence of signs of inflammation, or increased body temperature, of œdema, and of pain on pressure, point strongly to the swelling being of a sarcomatous nature. But these signs may be present in rapidly growing sarcomata, and may be but faintly marked, or not apparent, in inflammatory affections. A steady increase of the growth whilst under observation, notwithstanding rest and appropriate remedies for inflammation, the gradual loss of weight and strength, and the unequal consistency and irregular surface of the swelling, are more certain indications of its malignancy; but puncture with a grooved needle, or even an exploratory incision, may be required before the nature of the tumour can be cleared up. From an aneurysm, a pulsating sarcoma may be very difficult to distinguish, especially when growing from the pelvic bones. In the tumour the pulsation is not equally expansile over all parts, and although it may be stopped by pressure on the artery above, the tumour does not become smaller; nor is it felt to refill when the pressure is removed during two or three beats of the heart, as in aneurysm; and a bruit, if present, is not so distinct. Portions of expanded bone, moreover, may be felt in parts of the tumour, and there may be glandular enlargement and other general signs of malignancy. From an inflammatory condition of a neighbouring joint a tumour of the end of the bone may generally be distinguished by the absence of signs of inflammation; by the swelling being less regular in contour than in a joint-affection, and apparently being connected more intimately with one of the bones entering into the articulation than with the other; and by a careful review of the history of the case. Some help may also be obtained by the *x* rays.

Treatment.—Periosteal growths, unless the glands are much enlarged and there is evidence of dissemination having occurred, call for amputation of the limb, or removal, if practicable, when growing from the bones of the head or trunk. Small growths, however, may at times be dissected off the shafts of the long bones, and the surface of the bone scraped, gouged away, or destroyed by the actual cautery. Endosteal growths, if small, may in some cases be enucleated, but usually, like the periosteal variety, call for amputation. In some situations, as in the head of the radius, the affected portion of bone may be excised. The treatment of sarcomata of the jaws and of other special regions is described under Tumours of the Jaws, &c.

CARCINOMA never occurs as a primary growth in bone. It may spread to the bone, however, from the skin or mucous membrane, as seen, for example, in some cases of squamous carcinoma of the leg or lip, or be deposited there in the course of the general dissemination following on primary carcinoma of other tissues or organs, as the breast or liver. In the latter case it is seldom discovered till after death, unless it gives rise to spontaneous fracture (Fig. 78). *Treatment.*—Where epithelioma has spread to the bone, free and early removal with the knife before the glands have become affected is the only treatment that holds out a prospect of success. In the case of a limb, amputation well above the disease is generally called for, although where the bone is but little involved a free sweep of the growth and the gouging away of the underlying bone may under some circumstances be justifiable. Glands that have become affected should be removed if practicable.

CYSTS IN BONE are rare, except in the jaws. Hydatid cysts are occasionally met with, but require no special description (see p. 88). The sanguineous or blood cysts formerly described were probably sarcomatous tumours, in which hæmorrhage had taken place.

ANEURYSMS IN BONE are occasionally met with, and VASCULAR ERECTILE TUMOURS consisting of anastomosing vessels, and somewhat resembling nævi of the soft tissues, at times occur in the bones of the skull. The majority of pulsating tumours in bone, however, are of the nature of soft sarcomata.

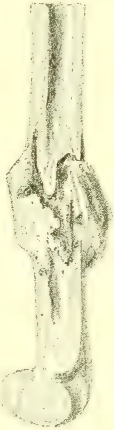


FIG. 78. — Secondary carcinoma of the shaft of the humerus causing spontaneous fracture of the bone. (St. Bartholomew's Hospital Museum.)

DISEASES OF JOINTS.

SYNOVITIS, or inflammation of the synovial membrane, may be acute, subacute, or chronic.

ACUTE SYNOVITIS.—*Cause.*—Generally a slight injury, as a sprain or over-exertion of a joint, or exposure to cold and wet in a gouty or rheumatic subject. Synovitis, moreover, especially in the knee, often occurs during an attack of gonorrhœa, and is sometimes seen in the earlier stages of syphilis. It is well known as a symptom of acute rheumatism and pyæmia, in which latter affection rapid suppuration and implication of the other tissues of the joint occur.

Pathology.—The synovial membrane becomes red and congested and loses its lustre, the synovial fringes turgid, and the synovial fluid increased in quantity and slightly turbid from admixture with inflammatory products. Resolution may now occur, or the inflammation may become chronic, or it may spread to the cartilages, bones, &c., and terminate in suppuration and the probable disorganization of the joint (see Acute Arthritis).

Signs.—The joint is hot, excessively painful, especially on movement and pressure, and if the inflammation is very intense, the skin may be slightly reddened, and the tissues around œdematous. The joint is usually held flexed, that is, with the capsule and ligaments relaxed,—the position of greatest ease. Where the joint is superficial the swelling is well marked, the outline of the synovial membrane being distinctly mapped out. Thus in the *knee*, the joint perhaps most commonly affected, the synovial membrane can be seen extending upwards under the crureus and vasti, and bulging on either side of the ligamentum patellæ. The patella itself is raised from the condyles of the femur, and on making pressure on it the fluid is displaced, and the patella can be felt to strike against the condyles (*riding of the patella*). In the *elbow*, the synovial membrane can be seen extending under the triceps and on either side of the olecranon; in the *ankle*, bulging beneath the extensor tendons and behind the malleoli. Feverish symptoms, varying in intensity according to the severity of the inflammation, are generally present. The inflammation may now gradually subside or assume the chronic form. Should, however, suppuration occur, and the other tissues of the joint become involved, the pain, swelling, and œdema increase, and the skin becomes of a dusky red, whilst a chill or distinct rigor ushers in a more severe type of inflammatory fever (*septic absorption*).

Treatment.—The joint should be placed at absolute rest on a splint, and the patient, in the case of the hip, knee, or ankle, confined to bed. In applying the splint care should be taken that the limb is in the position best suited for future use should ankylosis ensue; thus the knee should be straight, and the elbow bent at a right angle. Where the joint has already been drawn into a faulty position, this must be rectified, the patient being placed under an anæsthetic, as the manipulation is attended with intense pain. Cold, by means of evaporating lotions or Leiter's tubes, may in slighter cases be applied to the joint. When, however, the inflammation is very acute, half-a-dozen leeches followed by hot applications should be substituted for the cold, with liniments of belladonna and opium to assuage pain. Where there is much distension and the synovial membrane threatens to give way, the joint should be aspirated and elastic pressure applied, or if suppuration occurs, laid freely open and drained antiseptically. Amputation may be called for should the patient's powers fail under the long-continued suppuration that at times ensues.

SUBACUTE SYNOVITIS.—The term subacute is applied to less severe cases of acute synovitis. But as one form of the disease differs from the other in degree rather than in kind, and as the causes, symptoms, and treatment are similar, no special description is required.

CHRONIC SYNOVITIS.—*Causes.*—Similar to those of the acute form, of which it is often a sequel. When occurring in debilitated so-called strumous subjects, it probably nearly always depends on the presence of the tubercle bacillus, and will be described under *tuberculous disease of the joints.*

Pathology.—The synovial membrane is slightly thickened, and the synovial fluid increased in quantity; but there is little or no change in the cartilages or the other tissues, though, if the disease is neglected, it may run on to total disorganization of the joint. At times the synovial membrane becomes greatly distended with clear serous fluid, a condition known as *hydrops articuli*, and in this state it may remain for years without any further change ensuing; or, after long periods, the synovial membrane may become thickened, and little masses of cartilage form in its hypertrophied fringes. In other instances pouch-like protrusions of the synovial membrane may extend along the muscles and other tissues, often to some distance from the joint, where they give rise to bursa-like swellings (*Morrant Baker's cysts*).

Signs.—The joint, as in the acute affection, is swollen, and the synovial membrane slightly thickened; but there is little or no heat, there may be no pain, and the skin is unaltered in appearance.

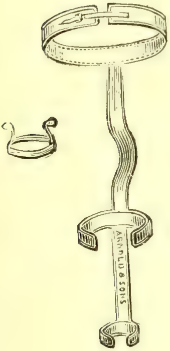


FIG. 79.—Thomas's hip-joint splint (front view) with patten.

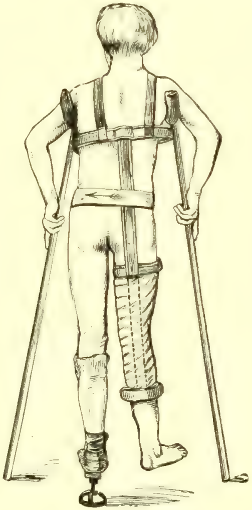


FIG. 80.—Thomas's hip-joint splint applied. Patten on sound limb. (Heath's Minor Surgery.)

The patient, however, complains that the joint feels weak and stiff on movement, but he does not suffer from starting-pains at nights. In *hydrops articuli* the synovial membrane is greatly distended but not thickened, and save a sensation of weakness and want of security in the joint on walking, the affection gives no trouble. In what may be termed the *bursal variety* of chronic synovitis, in addition to the joint-affection, more or less tense, fluctuating and translucent swellings occur in the neighbourhood of the joint. On pressure, these swellings become less tense, and some of the fluid contained in them can at times be forced back into the joint.

Treatment.—The indications are (1) to prevent further irritation by placing the joint at perfect rest, (2) to promote the absorption of the inflammatory products by pressure and counter-irritation, and (3) to remove any stiffness that may remain on the subsidence of the inflammation by passive movements, massage, or the breaking down of fibrous adhesions. Thus, the joint should be fixed in an accurately-fitting poroplastic or a moulded leather splint, or a plaster-of-Paris bandage; and the limb, if a joint of the upper extremity is affected, should be carried in a sling. In the case of the lower extremity, the patient, if unable to lie up, may wear a Thomas's hip or knee splint, according to the joint affected, and be allowed to get about on crutches with a patten fixed to the boot of the sound limb (Figs. 79, 80, 81 and 82). Pressure may be applied by strapping the joint with ammoniacum and mercury plaster, or with Scott's dressing, or by means of a Martin's bandage. Counter-irritation may be effected either with the liniment of iodine, small flying blisters, or the actual cautery. Rest, however, though most essential in the treatment, should not be continued too long, lest the joint become stiff. Should this happen, friction, massage, and passive movements must be sedulously used, or if all signs of inflammation have ceased, the adhesions may be broken down under an anæsthetic. In the meantime, the patient's general health must not be neglected, and any constitutional tendency to gout, rheumatism, &c., should be corrected by appropriate remedies. During convalescence a stay at Buxton, Harrogate, Wiesbaden, or some other suitable spa may be of benefit. In very obstinate cases the joint may be opened on its lateral aspect, and as much of the synovial membrane as can be reached cut away. This treatment has been attended by much success of late years, but should only

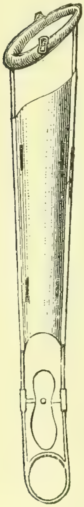


Fig. 81.—Thomas's knee-joint splint with foot-piece for extension. (Heath's Minor Surgery.)

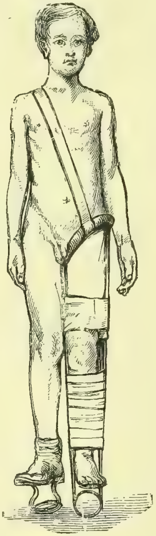


Fig. 82.—Thomas's knee-joint splint applied. Patten on sound limb. (Heath's Minor Surgery.)

be undertaken when other means have failed. In *hydrops articuli* the treatment recommended above may first be perseveringly tried. After prolonged rest has failed massage of the limb with exercise of the joint may sometimes effect the absorption of the fluid; this failing, the joint may be aspirated and pressure re-applied. Should it refill, it may be injected with iodine, or in very severe cases laid open, well washed out, and drained. Where cysts have formed in the neighbourhood of the joint, they should, if pressure fails to cure them, be left alone or dissected out and the neck tied. It is not safe to puncture them, for fear of setting up suppuration in the joint, and even a free incision, with antiseptic precautions, is not devoid of risk.

ACUTE ARTHRITIS is the term applied to a general inflammation of all the tissues of a joint. It may begin in the synovial membrane, in the articular ends of the bones, or in the tissues around, but in whatever way it begins, the whole joint rapidly becomes involved in the inflammatory process.

The *causes* are very various, and include those given under acute synovitis. Among the most frequent causes, however, may be mentioned penetrating wounds, infective periostitis or osteo-myelitis, epiphysitis, the bursting of an abscess in the soft parts or in the end of the bone into the joint, pyæmia, and the continued and the exanthematous fevers.

Pathology.—The course of the disease differs somewhat according to its cause and mode of origin. In a typical case beginning in the synovial membrane and running on to complete disorganization of the joint and subsequent ankylosis the following changes occur:—The inflammation rapidly spreads from the synovial membrane to the bones and surrounding soft tissues; the cartilages are destroyed; the ligaments are softened; the articular surfaces are displaced by the action of the muscles; and the joint is converted into the cavity of an abscess (Fig. 83). The capsule of the joint now gives way, allowing the inflammatory products to escape. The soft tissues break down into pus, and the abscesses open externally, forming sinuses leading down to the joint. Should the inflammation now subside, granulations spring up from the denuded ends of the bones, the two layers of granulations unite, and after passing through a fibrous stage undergo ossification (*bony ankylosis*), leaving the patient with a stiff joint. The pathological process by which these changes are brought about is as follows:—The synovial membrane, which at first appears red and injected, rapidly becomes infiltrated with inflammatory products, and is converted, together with the adjacent capsules, into a thick layer of granulation-tissue. The inflamed articular ends of the bones also become infiltrated with inflammatory products and pass through the changes described under Rarefying Osteitis. The cartilages thus cut off from their nutrient supply lose their lustre, and while portions die and are cast off into the interior of the joint, the rest is invaded both on its free and deep surface by the granulations derived from the synovial membrane on the one hand, and from the articular end of the bone on the other. As the result of this invasion, the cartilaginous matrix liquefies, and the cartilage cells proliferate, while the brood of young cells thus formed, in part coalesce with the cells of the invading granulation-tissue, and in part escape into the joint in the form of pus. The soft tissues around the joint are now invaded by the granulation-tissue, abscesses form, the skin gives way, and sinuses are left leading to the interior of the joint. After the inflammatory products have escaped, should the inflammation subside, the layers of granulation-tissue, which spring up from the surface of the bones that have been denuded of their cartilage, come into contact, and unite in the way described under Union of the Soft Parts by the Third Intention. Ossification subsequently ensues. Under less favourable circumstances the inflammation may assume a septic character, and the abscesses around the joint burrow widely amongst the muscles and other soft tissues; or the periosteum or the medulla of the bones may become involved in the septic inflammation, and extensive caries or necrosis ensue. The septic products may become absorbed, and the patient die of sapræmia or pyæmia, or suppuration may continue and death result from hectic or lardaceous disease.

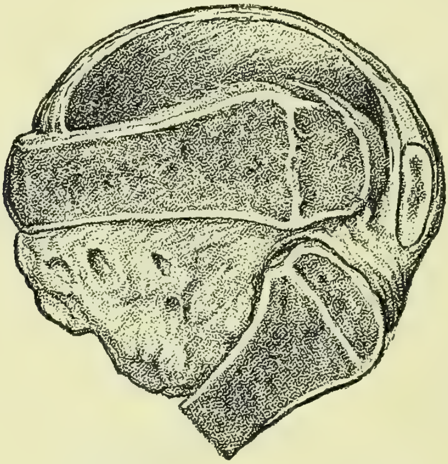


Fig. 83.—Acute arthritis of the knee-joint beginning in the synovial membrane. The ligaments are almost destroyed and the tibia is displaced backwards and outwards. The joint was filled with pus. (St. Bartholomew's Hospital Museum.)

Signs.—The disease may begin like an ordinary attack of synovitis, but the pain soon becomes intense and agonizing on the least movement, the heat more marked, and the skin often covered by a blush of redness. The swelling at first takes the form of the synovial membrane, but soon becomes general, and the joint assumes a flexed position. In the meantime the constitutional disturbance is severe, the temperature high, the pulse rapid, the tongue furred, and a chill or rigor may perhaps occur. Painful startings of the joint now set in, in consequence of the reflex irritation of the muscles; abscesses form and make their way to the surface, and burrow in the tissues around; and the joint-surfaces become displaced from each other (Fig. 83). After the abscesses have opened, the inflammation may subside, probably leaving the joint stiff; or the patient may die of septic poisoning or of exhaustion.

The *treatment* at first should be similar to that of acute synovitis; but should suppuration set in, the joint must be freely opened and antiseptically drained, and all abscesses that have formed around treated in the same manner. When effectual drainage cannot be secured continuous irrigation or immersion in a hot bath may be tried. If septic poisoning or exhaustion threaten life, amputation must be performed.

EPIPHYSITIS is an inflammation of the soft, growing tissue between the shaft and the epiphysis. It is therefore necessarily confined to the young, and is of most frequent occurrence under the age of ten. It may be acute, subacute, or chronic, and may or may not involve the neighbouring joint. The epiphyses most often affected are those of the hip, knee, and shoulder, but several may be implicated at the same time, or one after the other in rapid succession.

Cause.—Slight injuries, tubercle, infective micro-organisms, and sepsis as from the absorption of a septic poison after ligature of the umbilical cord.

Pathology.—The inflammation as a rule terminates rapidly in suppuration, in which case either the articular cartilage may be perforated and the pus escape into the joint, setting up acute arthritis, or the epiphysis may become completely cut off from the diaphysis and form, as in the case of epiphysitis of the upper end of the femur, a loose sequestrum in the interior of the joint. In less acute cases the inflammation may subside without suppuration ensuing, under which circumstances premature synostosis may take place between the diaphysis and epiphysis, and the growth of the bone at the affected end be thus arrested. The chronic cases may also terminate in suppuration and destruction of the joint; but if this does not occur, the prolonged vascularity may lead to increased nutritive changes, and instead of growth being arrested by premature synostosis, the bone may be increased in length.

Symptoms.—Severe constitutional disturbance; swelling of the end of the bone; tenderness, heat, and sometimes redness of the skin; stiffness and fixidity of the joint; pain increased on movement; and probably, later, signs of acute arthritis; grating of the epiphysis on the diaphysis; and if the capsule of the joint bursts, the formation of a large abscess in the limb. In the chronic form the signs are those of the early stage of tuberculous joint disease.

The *treatment* consists in placing the limb in a corrected position on a splint, the application of a few leeches, and free incisions down to the epiphysis with antiseptic precautions as soon as there are signs of suppuration. Should it appear probable that pus is contained in the epiphysis the latter should be cautiously perforated. If the joint, notwithstanding this treatment, becomes affected, it must be laid freely open and drained antiseptically, and any sequestrum that may be present removed.

GONORRHŒAL ARTHRITIS, commonly called gonorrhœal rheumatism, is not infrequent during an attack of gonorrhœa. It probably depends upon the presence of the *gonococcus* of Neisser, which can occasionally be found in the tissues and fluids of the affected joint, and has nothing to do with rheumatism, though a patient with gonorrhœal arthritis may of course be also the subject of rheumatism. The joint-affection may take the form of a more or less severe arthralgia, which soon passes off, or of an acute or chronic inflammation with effusion into the synovial cavity. The inflammation, which is often very intractable, usually ends in resolution, but may lead to ankylosis or to suppuration and destruction of the joint. The disease is generally confined to one joint, most commonly the knee. It is also common in the tarsal joints, when it is liable to be followed by flat-foot. Relapses are frequent.

The *signs* vary according to the form the disease takes, and are similar to those described under Acute and Chronic Synovitis and Arthritis (see pp. 229, 233). The discovery of the urethral discharge and the absence of other signs of ordinary rheumatism will settle the *diagnosis*.

The *treatment* will consist in the use of such remedies as are given in the section on Gonorrhœa, and in the employment of such local measures as are mentioned under Acute and Chronic Synovitis and Acute Arthritis.

HÆMOPHILIC ARTHRITIS.—An effusion of blood into a joint may occur either spontaneously or as the result of a slight injury in hæmophilia. The blood may be effused into the synovial cavity only, where it coagulates and then becomes slowly absorbed; or into the tissues as well, where it may set up subacute inflammation, leading to thickening of the synovial membrane, destruction of the cartilages or their detachment in flakes from the bone. Adhesions may form, but suppuration never occurs.

Signs.—The joint becomes suddenly distended without other sign of inflammation. As the blood coagulates a peculiar tearing crepitation may be detected. If secondary changes occur creaking is felt, with limitation of movement and some lipping around the articular surfaces.

Treatment.—Rest and cold, and later, elastic support, strapping and massage. No cutting operation, or even puncture, is permissible, for fear of uncontrollable hæmorrhage.

SYPHILITIC ARTHRITIS.—In the earlier stages of syphilis neuralgia in the joints or simple effusion into the synovial cavity is not uncommon; and in the later stages gummatous infiltrations of the synovial membrane, capsule, ligaments and bones may occur. The joint then becomes irregularly swollen, whilst hard or softening masses are felt in one or more situations. There is but little heat, and there may be but little pain on movement, but severe nocturnal pains are present. There is no redness unless the gummatous deposit is breaking down, and is making its way towards the skin, when there is the usual localized dusky red discoloration characteristic of a softening gumma. Other evidences of syphilis will probably be present.

Treatment.—Mercury in the young, iodide of potassium in the old, and in both a nourishing diet, with cod-liver oil and tonics. Locally, rest in the earlier stages, and later massage.

CHRONIC TUBERCULOUS ARTHRITIS, also called tumor albus or white swelling, pulpy degeneration of the synovial membrane, and fungous or strumous inflammation, is characterized by a gradual enlargement of the joint, unaccompanied by redness or much increase of synovial secretion. It begins very insidiously, is chronic in its course, and is prone to end in the total disorganization of the joint. Though most frequent in the young, it may occur at any age.

Causes.—It is generally attributed to some slight injury to the joint, occurring in a strumous or unhealthy subject; but frequently no history of any such injury is forthcoming. The immediate cause is the presence of the tubercle bacillus which has gained admission to the system in the way described under Tubercle.

Pathology.—The disease may begin either as a chronic inflammation of the synovial membrane, or as a fungating caries of the articular ends of the bones; in the former case, the synovial membrane, which first appears red and injected, gradually becomes thickened and œdematous, and ultimately pulpy and gelatinous and in places fatty-looking. The synovial fluid in the meantime becomes turbid or muco-purulent, but is rarely much increased in quantity; the synovial tufts, at first soft and flocculent, gradually assume the form of spongy granulation-tissue, and grow over the cartilage from the sides till they completely cover it, "lying over it like a veil." Prolongations from this veil of granulations, compared by Billroth to the roots of ivy penetrating a wall, insinuate themselves into and spread in all directions through the cartilage, which they ultimately destroy, and then in like manner invade the bone. The granulation-tissue may also make its way between the bone and the cartilage, and unite with that derived from the synovial membrane, thus leaving portions of cartilage loose between the two layers of granulations. At the same time, fungous granulations derived from the synovial membrane may invade the tissues around the joint, and undergoing caseous or fatty degeneration in places, break down into abscesses which may open both externally and into the joint, leading to the production of sinuses and fistulæ. The ligaments being thus softened and destroyed, allow the articular surfaces to be dislocated by the contraction of the muscles; whilst the muscles and bones themselves, partly from want of use and partly from the debilitating nature of the disease, undergo atrophy and fatty degeneration. *When the disease begins in the bone* it takes the form of a rarefying osteitis, the fungating granulations invade the deeper surface of the cartilages, perforate them, and then set up the changes in the synovial membrane and other tissues described above. *The minute changes* which occur during the above-mentioned phenomena are those already described under Inflammation. All that need be repeated here is, that the synovial membrane, ligaments, and in places the surrounding tissues, become infiltrated with small round cells, and ultimately converted into a layer of vascular granulation-tissue; that the cartilage-cells proliferate whilst the matrix undergoes softening and liquefaction; and that the articular ends of the bones are eroded and destroyed in the way described under Caries. In places in the granulation-tissue are found non-vascular areas, consisting of tubercle nodules, in which the tubercle bacillus is found. In the early stages under appropriate treatment the inflammation may subside, and the joint resume its normal condition. After the cartilages, however, have been destroyed, such a favourable ending is of course impossible, and all that can be hoped for is that the layers of granulations covering the denuded bones may unite and ankylosis ensue. The dangers to be apprehended are that the tubercle should become disseminated, lighting up phthisis, meningitis, &c.; or that long-continued suppuration should induce hectic, exhaustion, or lardaceous disease.

Signs.—The disease is generally chronic, often lasting for years. It usually begins very insidiously: there may be some slight stiffness of the joint, attributed perhaps to a trivial injury, or in the case of the lower extremity a slight limp in walking. The joint may be held in a slightly-bent position, and the range of flexion and extension may be somewhat restricted. Occasionally the disease is ushered in by an acute attack of synovitis. At first there may be little or no swelling, or the swelling may take the form of the synovial membrane; but as the disease advances, it becomes general and uniform, so that the points of bone about the joint become obscured. The wasting and atrophy of the tissues of the limb, however, give the articular ends of the bone the appearance of being considerably enlarged. In the meantime there is no redness of the skin; hence the name *tumor albus*, or *white swelling*. Pain at first may be absent, or only present on movement of the limb, but gradually increases till the patient, in the case of the lower extremity, is prevented by it from walking. There is usually but little heat. In this condition the joint may remain for many months, and under appropriate treatment the disease may completely subside. If neglected, however, the articular surfaces of the bones, as the ligaments become softened, are slowly displaced, and painful startings of the limb at night indicate that the bones are involved. Now tenderness followed by fluctuation may be detected at one or more spots; the skin becomes red in these situations; and the abscess if not opened, bursts externally, allowing of the escape of curdy pus. Thus, by the formation of successive abscesses, the tissues around the joint are slowly undermined, and sinuses and fistulæ are formed. The general health becomes more markedly affected, and although even now the sinuses and fistulæ may heal and the patient ultimately recover, though almost certainly with an ankylosed joint, suppuration as often continues, hectic sets in, and the patient dies of exhaustion, or succumbs to phthisis or lardaceous disease.

The *treatment* must be both local and constitutional. The local indications are (1), to place the joint at absolute rest in a position in which it will subsequently be most useful should ankylosis occur; (2), to keep it at rest, not only till all signs of the disease have disappeared, but for some months afterwards, to prevent a relapse; (3), to open and drain antiseptically any abscess that may form, or fully expose the cavity of the joint and remove the diseased tissues; and (4) in advanced and intractable cases to save the patient's life by the sacrifice of the limb. For keeping the joint at rest, splints may be employed similar to those mentioned under chronic synovitis; and in the case of the lower extremity, where there may be flexion of the hip or knee, the patient should be placed in bed, and extension made by a stirrup, weight and pulley, or by a Bryant's double splint, till the deformity has been overcome. The time the splints should be worn will vary in each individual case according to the progress of the disease. Roughly, it may be said that they will generally be required for many months, perhaps for several years, and that they must be worn three months after the disease has ceased. The *constitutional* means which must be adopted, are those that have already been described under the treatment of Tubercle (p. 48). Should the disease progress in spite of treatment, aspiration and the injection of iodoform-glycerine emulsion may be tried; the aspirations and the injections being repeated at frequent intervals, or the actual cautery may be employed in the following manner:—The patient having been anæsthetized, the skin disinfected, and any deformity in position rectified by tenotomy if necessary, the fine point of the thermo or electric cautery is passed into the joint at the spots where the fungosities are most marked. Thus in the knee the punctures should be made on each side of the patella and at the level of the bursæ beneath the extensor tendon, as many as fifteen to twenty punctures being, if necessary, employed. The joint is then dressed antiseptically and immobilized in plaster of Paris. Other treatment failing, the joint may be freely opened, the diseased synovial membrane scraped or cut completely away (*arthrectomy*), the cavity well flushed out with an antiseptic solution, filled with iodoform emulsion, and the wound closed. A convenient instrument for scraping out the joint will be found in Barker's flushing spoon, which admits of a stream of water or antiseptic solution flowing through the joint whilst the scraping is in progress. If the wound breaks down, the operation should be repeated, or if the whole of the diseased tissues cannot be removed an antiseptic drain may be employed. If the cartilages and articular ends of the bone are found much diseased, the joint should be excised. Where, however, notwithstanding the above treatment, abscesses and sinuses continue to form, and the patient is becoming exhausted by long-continued suppuration and hectic, or where signs of incipient phthisis or lardaceous diseases are becoming manifest, the question of amputation must be raised. Should recovery ultimately occur, but with the joint ankylosed in a faulty position, an osteotomy or osteoclasia may be of service.

Tuberculous disease of the hip, though essentially similar to tuberculous disease of other joints, requires separate mention, as owing to the depth and conformation of the articulation it is attended with special symptoms, and calls for certain modifications in the method of treatment.

Signs.—In the early stages there is slight lameness, some limitation in the range of movement of the joint, generally pain, and often quite early some atrophy and wasting of the muscles. The pain, though at times severe, is more frequently slight, and may only be elicited on making certain movements of the joint. It may be felt in the hip, or, as is commonly the case, be referred to the knee or to other parts supplied by the obturator nerve, as the inner side of the thigh. At times it may be felt in both hip and knee simultaneously. The joint is slightly stiff, not only on flexion and extension, but also on rotation and on abduction and adduction, especially in the semi-flexed position. There is often some fulness about the front of the joint, loss of the gluteal fold, and perhaps tenderness on pressure. The joint becomes at first slightly flexed, everted, and abducted, *i.e.*, it assumes the position in which the ligaments of the inflamed joint are most relaxed—the position of greatest ease. In order to bring the flexed and abducted limb to the ground, the pelvis is depressed on the affected side, and hence the limb appears when placed parallel to its fellow slightly lengthened (Fig. 84, A and B). Later, the joint becomes further flexed; but inverted instead of everted, and adducted instead of abducted, a change of position which has been variously attributed to erosion of the posterior part of the acetabulum, a yielding of the ligaments, or exhaustion of the external rotator and abductor muscles. To overcome this position of adduction in which the limb is useless, the pelvis is raised on the affected side, so that the limb, if brought parallel to the other, now appears slightly shortened (Fig. 84, C and D) in place of being lengthened. Whilst the position of abduction and adduction is overcome by depressing or raising the pelvis respectively on the affected side, *i.e.*, by laterally bending the lumbar spine, flexion is overcome by rolling the pelvis

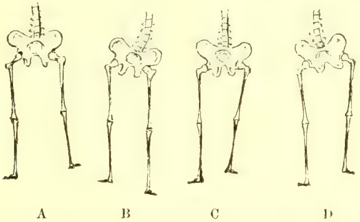


FIG. 84.—To show the effects of abduction (A), and adduction (C) in causing apparent lengthening (B), and apparent shortening (D) of the limb in hip-joint disease, when the affected limb is placed parallel to the opposite limb.

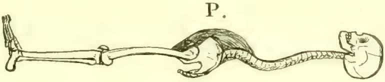


FIG. 85.—To show the lordosis of the lumbar spine when the limb is placed in the straight position. P. Psoas muscle.

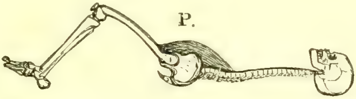


FIG. 86.—To show effect of flexing the limb on the lumbar lordotic curve. P. Psoas muscle.

forward, *i.e.*, by increasing the normal lumbar curve. Hence when the patient is laid on his back and the limbs are brought down parallel to each other, there is always considerable lordosis of the lumbar spine (Fig. 85), which, however, disappears on flexing the affected limb to the angle at which it is held flexed by the contracted muscles (Fig. 86). Later in the disease real shortening ensues, owing to the destruction of the joint and the dislocation of the head of the bone on to the dorsum of the ilium. The pus usually makes its way towards the surface between the tensor vaginæ and sartorius, and a fluctuating swelling is produced in this situation a little below and external to the joint. Finally sinuses may form and the disease progress in the way described under Tuberculous Arthritis. Not infrequently the acetabulum may become perforated and the suppuration extend into the pelvis. Pointing may then occur above Poupart's ligament, or the pus may make its way into the rectum, ischio-rectal fossa, or through the sciatic notch. Hip disease, like other joint-affections, may be simulated in neuro-mimetic subjects (see p. 251), and reflex pain in the joint is not uncommon in phimosis.

Treatment.—As regards constitutional treatment nothing need be added to what was said on pp. 48, 239. The indications for the local treatment are similar to those for tuberculous disease of the joints generally, but require certain modifications in the methods of carrying them out. Thus if the symptoms are acute the patient should be placed in bed, and extension made by the stirrup, weight and pulley in the direction in which the joint is displaced, the limb being gradually brought down in this way to a straight position. If the child is restless a long splint should be placed on the opposite limb to keep him from rolling to one or other side, whilst the foot of the bed should be raised by blocks to prevent him slipping down, or Bryant's double splint may be used with great advantage in some cases (Fig. 208). Subsequently, or at once in subacute cases, a Thomas's splint (Fig. 79) should be applied, and after the limb has been brought into the straight position, the patient may be allowed to get about on crutches. If in spite of treatment, the disease progresses and pus forms, aspiration and the injection of iodoform-glycerine emulsion may first be tried, the aspiration and injection being repeated at frequent intervals. This failing, the abscess should be opened, the diseased tissue scraped away, the cavity filled with the iodoform emulsion and the wound closed. The head of the bone if loose or carious should be removed, as should also any carious bone that can safely be got away from the acetabulum. When all the carious bone cannot be removed, or the suppuration has extended into the pelvis, an antiseptic drain should be employed, the wound being stuffed with iodoform gauze daily. One advantage of early incision is that the pus in some cases may at first be outside the joint, being dependent upon disease about the great trochanter, lower end of the neck or upper end of the shaft, and so extension to the joint may be avoided. In intractable cases amputation at the hip joint is often the only chance of saving the patient's life. In lieu of amputation at the hip, Mr. Howse has proposed amputation through the thigh, either as a preliminary to the more serious amputation or altogether instead of it. He argues that such a measure, by reducing the length of lever having its fulcrum at the hip-joint, promotes rest, and by removing a mass of tissue chiefly blood-consuming and very little blood-producing, favours the production of blood of better quality and larger amount; whilst should amputation at the hip become absolutely necessary later there would be less shock and the patient would be better able to bear it. Should the patient recover but with the limb ankylosed in a flexed or other faulty position, the division of the femur subcutaneously with the chisel or Adams' saw below the trochanters will be required to put it straight.

Disease of the sacro-iliac joint also requires a separate, brief notice. It is generally of tuberculous origin, but is sometimes apparently due to injury. It usually occurs in young adults, rarely, if ever, in children. There is pain, swelling, and later redness over the joint, followed by the formation of abscesses which may open posteriorly or through the sciatic notch, above Poupart's ligament, in the ischio-rectal fossa, or in the rectum. The pain may be reflected along the sciatic nerve, simulating sciatica, or along the obturator nerve to the hip or knee, and may then be increased on moving the hip. The thigh, moreover, in consequence of the irritation of the psoas, may be slightly flexed. The disease may thus have to be diagnosed from hip-disease and spinal caries. On fixing the pelvis, however, the hip and spine move freely and without pain, but pain is felt on making pressure inwards or outwards on the iliac crests or over the sacro-iliac joint. When sinuses have formed carious bone may sometimes be detected on probing. The *prognosis* is unfavourable. The *treatment* consists in keeping the parts at absolute rest by fixing the pelvis and thigh in a moulded leather splint reaching to the knee. If this fails the joint may be exposed, before abscesses or sinuses have formed, by cutting off the posterior angle of the crest of the ilium and chiselling away the adjacent bone. The diseased tissue should then be scraped away, and the wound plugged with iodoform gauze. After sinuses have formed, as much as possible of the tuberculous granulations and carious bone should be scraped and gouged away and the wound dressed with iodoform gauze, but the results then are unsatisfactory.

Chronic rheumatic arthritis must be distinguished from osteo-arthritis or rheumatoid arthritis as it is sometimes called. It may be the result of repeated attacks of acute rheumatism, or it may be chronic from the first. It may affect a single joint (*monarticular rheumatism*), or several joints simultaneously or in succession (*polyarticular rheumatism*). In rheumatic arthritis there is no destruction of cartilage, eburnation of the bones, nor formation of osteophytes as there is in osteo-arthritis, but the synovial membrane becomes slightly thickened, and the synovia either increased in quantity, when fluid may be detected on palpation, or diminished, when gratings or creakings occur. Later, adhesions may form in and around the joint, leading to more or less fibrous ankylosis.

Treatment.—The *general* is that for rheumatism, with residence at a suitable spa, as Bath, Buxton, Harrogate, or Wiesbaden. The *local* consists in hot baths, massage, passive movements, and if ankylosis has occurred, in breaking down of adhesions under an anæsthetic. I have found the Tallerman-Sheffield localized hot air bath of service in these cases for softening adhesions and restoring movement.

CHRONIC GOUTY ARTHRITIS most commonly affects the smaller joints, and preferably the metatarso-phalangeal joint of the great toe. It is characterized by the deposit of urate of soda in and upon the cartilages, and frequently in the connective-tissue around the joints, giving rise to chalk stones (*Heberden's nodes*). The affected joints after several attacks become stiff and deformed, and ulceration of the skin may lead to exposure of the chalk stones. The symptoms and treatment are those of gout. See work on Medicine.

CHRONIC OSTEO-ARTHRITIS, also called rheumatoid arthritis, or arthritis deformans, is an incurable and progressive disease leading to great deformity, and at times to complete disablement of the joint. It is characterized by gradual degeneration and destruction of the cartilages, eburnation and alteration in the shape of the articular ends of the bones, and formation of nodular osteophytes in the fibrous tissues around the joint. It is a disease of middle and advanced life, and may be confined to one or more of the larger joints—the hip, knee, or shoulder, or it may affect many joints, including the smaller articulations. Though most frequently met with in the joints of the extremities, it may affect other joints, as those of the lower jaw, spine, &c.

The *cause* is not known. The disease, however, has been attributed to deficient or perverted innervation, depressing nervous influences, exposure to cold and damp, improper feeding, insufficient clothing, &c. At times a slight injury appears to be the determining cause.

Pathology.—The disease is variously believed to begin as a chronic inflammation of the synovial membrane, a fibroid degeneration of the cartilages, or as an inflammatory affection of the ligaments.

In whichever way it begins, however, the earliest characteristic changes are found in the cartilages. These at first appear nodular and cracked, but subsequently become roughened, fibrous and villous-looking, and are finally rubbed away by the friction of the articular surfaces of the joint on each other. Such changes appear to be due to fibroid degeneration, or splitting of the matrix into fibres, and the multiplication, enlargement, and fatty degeneration of the cartilage cells. Thus it will be perceived that the process by which the cartilages are destroyed in chronic osteo-arthritis differs materially from the so-called ulceration of cartilage which occurs in the inflammatory joint-affections previously described, and in which the matrix undergoes liquefaction and softening consequent upon its invasion by the granulation-tissue derived from the synovial membrane and bone. In chronic osteo-arthritis the synovial membrane, at first dry, becomes slightly thickened and vascular, and moderately distended with turbid synovial fluid which at times resembles train oil. In the meanwhile the synovial fringes become hypertrophied, and assume the form of pedunculated processes, often containing little masses of cartilage or bone. These little masses may subsequently become detached and form loose bodies in the joint (Fig. 87). The articular surfaces of the bone become smooth, hard, polished, eburnated, or porcellaneous in appearance and variously altered in shape—changes apparently depending in part on friction and mechanical pressure, and in part on the formation of new bone in the cancellous spaces, whereby the bone is rendered harder and is consequently capable of receiving a higher polish. Whilst, however, new bone is being formed immediately beneath the polished surface, rarefaction and atrophy are going on a little deeper in the bone, leading to the shortening and distortion so commonly observed. Hence, for example, the flattening and enlargement of the acetabulum and glenoid cavity, and the absorption of the neck and flattening of the head of the femur and humerus, seen in osteo-arthritis of the hip (Fig. 88) and shoulder respectively. At times the new bone in the cancellous spaces and Haversian canals is not formed as quickly as the polished layer of bone is worn away, and the open ends of the enlarged Haversian canals give the articular

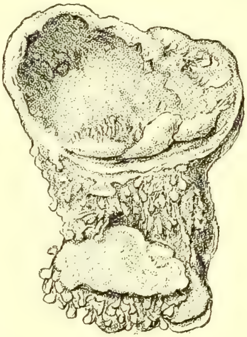


FIG. 87. — Chronic osteo-arthritis of the knee-joint. The articular surface of the tibia is shown in the upper part of the figure: the patella is turned down. (St. Bartholomew's Hospital Museum.)

surface a worm-eaten appearance. In the meantime out-growths of cartilage take place around the articular surfaces and undergo ossification, forming the low nodular flattened osteophytes and the "lipping" of the articular ends of the bone so characteristic of the disease. Ossification may also occur in the ligaments, tendons, and other soft structures around.

Signs.—In the earlier stages osteo-arthritis may be difficult to recognize. The following symptoms, however (*Spender's signs*), ? may occur before any distinct mischief in the joint is noticed: (1) "Rapidity of the heart's action, and increased arterial tension due to disturbance of the inhibitory action of the vagus; (2) Bronzed and discoloured patches on the skin, with clamminess and atrophic changes due to vasomotor derangement; (3) Pain in the ball of the thumb or along the inner side of the wrist."

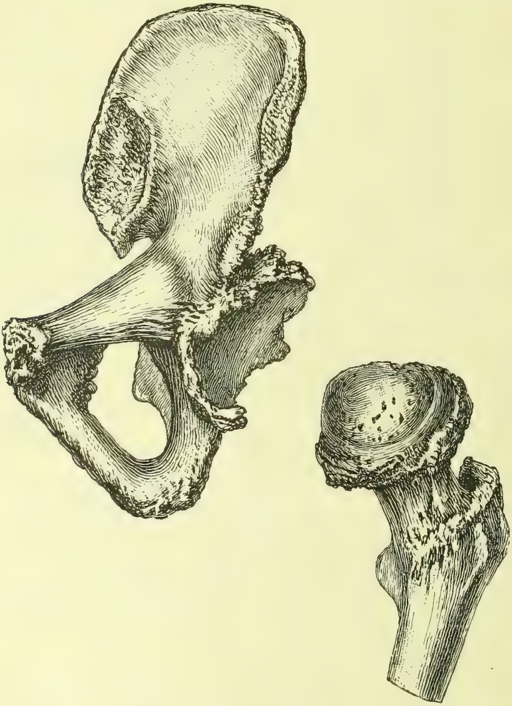


Fig. 88.—Chronic osteo-arthritis of the hip. (St. Bartholomew's Hospital Museum.)

When the disease is fully established it may be known by pain, increased on movement, and often worse at night and during changes of the weather; a characteristic creaking and harsh grating felt on moving the joint; the detection of masses of bone around; the limitation of the movement of the joint; and absence of heat and redness. In the hip there may be eversion, shortening, and much lameness; in the knee, swelling and thickening of the synovial membrane, and deformity of the patella; and in the shoulder, enlargement or displacement of the head of the bone. In the hip the disease may closely simulate intracapsular fracture of the neck of the femur; in the shoulder, dislocation of the humerus. (See *Fracture of Femur and Dislocation of Shoulder.*)

Treatment.—It is only at a very early stage that the disease is amenable to treatment; hence the value of Spender's signs, should they prove constant. The whole body should be warmly clad, the diet carefully regulated, stimulants prohibited or restricted in quantity, and a periodical visit paid to such spas as Buxton, Harrogate, Bath, Wiesbaden, Aix-les-Bains, or Wildbad. Locally, massage, friction, and passive movements, should be from time to time employed; the joint should be enveloped in wool or flannel, but should not be kept at rest on a splint, since this will only tend to increase the stiffness. In the way of drugs, cod-liver oil, iodine, iodide of potassium, arsenic, and guaiacum, are of most service. Blisters and fumigations of sulphur are recommended for relieving the pain. Unless arrested in the earlier stages the disease generally gets worse as the patient grows older.

CHARCOT'S DISEASE OR TABETIC ARTHROPATHY is an affection of the joints closely resembling osteo-arthritis. It is believed to depend upon degenerations in the spinal cord (locomotor ataxia), and therefore to be the result of trophic changes in the joint. The pathological changes are similar to those already described under osteo-arthritis, but the destruction of the joint is more marked. Briefly they may be said to consist in erosion of the cartilages, softening of the ligaments, grinding away of the articular surfaces and often of the contiguous portions of the shaft of the bone, induration of the remaining portions of the articular surfaces, thickening and at times pouchings of the synovial membrane, and formation of osteophytes around. Suppuration is very rare. These changes may affect one joint only, or may occur successively in several joints.

The *signs* in a typical case are as follows:—Sudden swelling of a joint, usually without much pain or any marked signs of inflammation, followed, on the subsidence of the swelling, by preternatural mobility, and the formation of processes of bone about the articular surfaces and in the surrounding muscles and tendons. There is great deformity, but not much pain either on movement or handling. Along with the local signs there are generally symptoms of locomotor ataxia, such as an unsteady gait, a tendency to fall on placing the feet together with the eyes closed, a jerking movement of the limbs, absence of the patella-tendon-reflex, lightning pains, spasmodic muscular contractions, local anæsthesia and sweating of the limbs, loss of response of the pupil to light but no loss of the power of accommodation (*Argyll-Robertson pupil*), sometimes optic atrophy, bladder troubles, and loss of sexual power. The joints most often affected are the knee, hip, and shoulder. In the tarsus the bones, on the subsidence of the swelling of the synovial membrane, though at first felt to be loosened by the softening of the ligaments, may ultimately become ankylosed.

Treatment.—Beyond keeping the part at rest during an acute attack, and adopting the same general treatment as is appropriate for osteo-arthritis and locomotor ataxia, little can be done. To relieve the pain antipyrin and exalgine may be tried. Suspension has at times been of service.

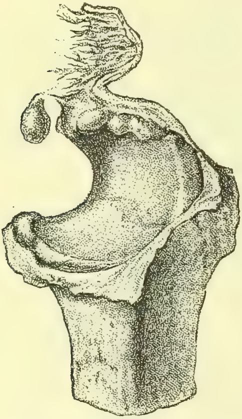


FIG. 89.—The formation of a loose cartilage in a joint. A little mass of cartilage attached by a slender stalk. (St. Bartholomew's Hospital Museum.)

LOOSE BODIES in a joint may be formed in several ways, of which the following are the chief:—1, by the proliferation of the cartilage cells that normally exist in the synovial fringes, and the subsequent detachment of the little mass of cartilage so formed through the rupture of its peduncle in the movements of the joint (Fig. 89); 2, by thickening or hypertrophy of a synovial fringe, or by extravasation of blood and subsequent organization of the fibrinous coagulum in a synovial fringe, detachment occurring in a manner similar to that in the former case; 3, by necrosis of a portion of the articular cartilages; and 4, by chipping off of a portion of the articular cartilage during some injury to the joint. Loose cartilages are most common in the knee, but may be met with in any joint. They are generally single, but may be multiple, and vary in size from a pea to a walnut.

Symptoms.—The chief symptom is pain, due to the loose body slipping between the ligaments and articular surfaces during the movements of the joint. In the knee this occurs during flexion; and on the patient attempting to straighten the joint the loose body, by forcing the articular surfaces apart, stretches the ligaments, and thus gives rise to a sudden and excruciating pain, perhaps so severe as to cause him to fall. At times the loose body remains fixed between the articular surfaces, the patient being then unable to straighten his limb. Such an attack may be followed by synovitis. On examination the body may often be felt somewhere in the synovial pouch, probably on the outer side of the joint in the case of the knee. If attached, its movements will be limited, but if free it can frequently be made to move round to the opposite side of the joint. It may perhaps disappear by passing into some of the synovial recesses, though it can generally be felt again on moving the joint.

Treatment.—If the loose body gives rise to little or no trouble, and can be easily fixed by a pad and bandage or knee-cap, it should not be interfered with; nor should any operation be undertaken where the joint is disorganized by osteo-arthritis, or where the synovial membrane is studded with masses of cartilage. Under other circumstances the loose body should be removed. This may be done by transfixing the loose cartilage with a strong needle on an aseptic handle thrust through the skin, so that the loose body may not slip away or be lost during the operation, and then cutting down on the capsule, and when all bleeding has been stopped, opening the joint. The body if loose will generally slip through the opening; if attached, its pedicle must be ligatured and divided. The operation should be performed with the strictest antiseptic precautions, and the patient prepared by a week's rest in bed in the case of the knee with his joint on a splint. The splint should be continued after the operation, or the joint placed in a plaster-of-Paris bandage till the wound has healed and all fear of inflammation has passed.

ANKYLOSIS OR STIFF JOINT may be divided into the *fibrous* and the *bony*. A spurious form of ankylosis, due to the contraction of the surrounding muscles or of cicatrices after burns, may also occur, but is generally associated with some amount of fibrous ankylosis.

Fibrous ankylosis, also called ligamentous, or by some authors, false, in contradistinction to the bony which they then term true, is the union more or less complete of the articular surfaces of the joint by fibrous tissue. Thus it may consist of—1, a mere thickening of the capsule; 2, a thickening and shortening of the ligaments; 3, the formation of fibrous bands within the joint; 4, the partial removal of the cartilages and the union of the bones by fibrous tissue; and 5, the above conditions variously combined. It may be the result of joint-disease, or of keeping an inflamed joint in too long a state of rest. Sometimes it may terminate in bony ankylosis.

Bony ankylosis is the firm union of the articular ends of the joint by bone. It is often a further stage of the fibrous variety. The articular surfaces may be united evenly and uniformly, or by irregular bridges of bone, or partly by bone and partly by fibrous tissue. The union may occur with the articular surfaces in contact in either the extended or the flexed position, or at an angle between the two (Fig. 90); or it may occur with the articular surfaces dislocated from each other. The way in which it is produced has already been described under Arthritis; all that need be repeated here is, that in tuberculous disease, ankylosis and caries may often be observed at the same time.

The *signs* of ankylosis are obvious—*i.e.*, the joint is stiff. It only remains to diagnose the fibrous from the bony. In the former there is slight movement, and generally pain; in the latter neither movement nor pain. In some instances, however, as in ankylosis of the shoulder and hip, the joint may be held so firmly by the contraction of the muscles that the fibrous may simulate the bony form; and again, although bony ankylosis may exist, the revolving of the scapula or pelvis, as the case may be, on the trunk may make it appear that there is some movement in the affected joint. A skiagraph or an examination under an anæsthetic will settle the point.

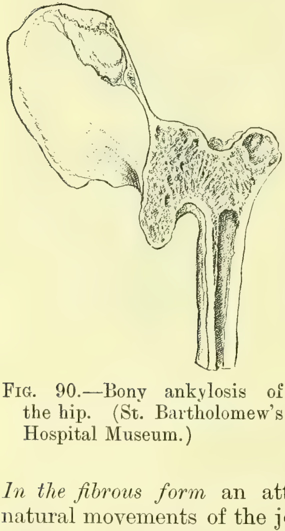


FIG. 90.—Bony ankylosis of the hip. (St. Bartholomew's Hospital Museum.)

The *treatment* will vary with the nature of the ankylosis. In the spurious form something may often be done by dividing the cicatrices, or by freeing the parts by a plastic operation, though in such cases the treatment is seldom very hopeful. *In the fibrous form* an attempt should be made to restore the natural movements of the joints—1, by manipulation, friction, and passive movements; 2, by forcibly breaking down the adhesions under an anæsthetic, at the same time dividing any tendons that may offer resistance; or 3, by gradual extension by a weight and pulley, or some form of cog-wheel or screw apparatus. An attempt to break down adhesions, however, should on no account be made whilst any signs of inflammation remain, and after the operation the limb should be placed on a splint for a few days, and cold by means of Leiter's tubes or an ice-bag applied to prevent inflammation. *Bony ankylosis*, with the limb in a good position, is often the best result that can be hoped for after the disease of the joint has reached a certain stage. But in some instances an operation may be required to restore movement, or to rectify a faulty position, Thus in an ankylosed elbow, especially when fixed in the extended position, excision of the joint should be practised. In a bent knee a wedge-shaped piece may be removed, or an osteotomy done. In the hip, subcutaneous osteotomy of the neck of the femur or of the shaft just below the trochanters may be undertaken. In the shoulder, no operation as a rule is required, as the movement of the scapula on the trunk is very free. When ankylosis is accompanied by much wasting of the limb, amputation may be necessary.

Hysterical joints.—Pain of a neuralgic character unassociated with heat, redness, swelling, or physical signs of organic disease, is occasionally met with in one or more joints, especially in young women of the neuro-mimetic temperament. They are very difficult cases to deal with, and should receive the greatest care and attention, lest an erroneous diagnosis be made. Nearly all the signs of organic joint-disease may be simulated; thus, there may be pain on movement, or some slight redness and heat of the part, or fixity of the joint. The pain, however, is generally superficial, and is not increased on movement of the joint if the patient's attention in the meanwhile is otherwise engaged; the redness and heat will often be found on inquiry to be due to previous friction or the use of irritants; and under an anæsthetic the rigidity of the joint completely disappears, its movements then being found to be free, smooth, and natural. Further, on recovery from the anæsthetic, the rigidity does not return until the patient again directs her attention to the joint, whereas in organic disease it returns as soon as the muscular relaxation ceases. The *treatment* consists in the employment of the ordinary remedies for hysteria, both locally and internally. See a work on Medicine.

Arthrectomy or erasion of joints consists in scraping or cutting away the whole of the diseased synovial membrane, after the cavity of the joint has been fully exposed by some such incision as that employed in excisions. It is a useful addition to our methods of treating diseased joints, and appears to be especially indicated for those cases in which the disease is too far advanced to yield to the ordinary plan of treatment, but has not as yet, or at least only to a slight extent, involved the cartilages and bones. The extent of the bone lesion, if any, can now be determined in some measure by the x rays, tuberculous deposits, being more transparent than bone, appearing as light areas in the skiagraph.

Excision or resection of joints consists in cutting away the articular surfaces of the bones entering into the affected joint, or in removing a portion of bone where osseous ankylosis has taken place. When excision is done for disease it may be said here to prevent repetition that the whole of the diseased synovial membrane should be cut or scraped away, as should also the lining membrane of any sinuses that may be present. Excision may be required for severe injury or for intractable disease of the joint. Space does not permit of the discussion of the various conditions under which excision should or should not be performed, but it may briefly be stated that it should *not* be undertaken—1, when the disease is acute; 2, when there is much destruction of the bones, or riddling of the soft parts with sinuses; 3, when there is much atrophy of the bones and muscles; 4, when the patient is under the age of ten or over that of forty, as, in the former instance, the epiphyses are liable to be removed and the growth arrested in consequence, and in the latter, the powers of repair are usually insufficient to ensure sound healing and a subsequently useful limb; 5, when there is lardaceous disease or signs of phthisis, or other organic mischief; and 6, when the patient's powers of repair are exhausted by long-continued suppuration. Under most of the above circumstances amputation is generally indicated. Excision is usually attended with the best success in the elbow, and here it may be done at a later period of life than that assigned above as the limit. In the shoulder, elbow, and wrist, fibrous ankylosis is aimed at in order to secure a moveable joint; in the hip and knee, firm bony union is sought in the most useful position of the limb, which is that of extension.

EXCISION OF SPECIAL JOINTS.—THE SHOULDER.—Excision of the shoulder is generally practised for gunshot injuries and for innocent tumours in the head of the bone. It is seldom performed for disease of the joint, as an equally useful joint may be obtained by osseous ankylosis. It should never be done for osseous ankylosis, as the movements of the scapula on the trunk are so free that they compensate to a great extent for the fixed condition of the joint, and little would be gained by the operation. Of late excision has been employed for unreduced dislocations of the shoulder, where after free exposure and division of contracted tendons and ligaments, the bone cannot be replaced. *The operation.*—Make an incision about four inches long from just outside the coracoid process through the substance of the deltoid down to the bone; detach the long tendon of the biceps from its groove, and give it to an assistant to hold aside with blunt hooks. The arm being rotated inwards, divide the teres minor, infraspinatus, and supraspinatus tendons at their insertion into the bone. The arm being next rotated outwards, divide the tendon of the subscapularis, and the head of the bone can be pushed out of the incision. Separate the periosteum as far as is necessary, place a retractor behind the neck of the bone to protect the soft parts, and saw it across. Bring the wound together by suture, place a drain tube in the lower part, and dress antiseptically.

THE ELBOW may be excised for chronic disease of the joint, gunshot or other injury, and osseous ankylosis. Some surgeons only recommend excision for ankylosis when the elbow is fixed in a faulty position. The operation, however, is attended with so little risk, the advantages of a moveable elbow are so great, and the results so good, that others unhesitatingly excise the joint in whatever position it may be fixed. The *operation* may be performed in several ways; but that by the single vertical incision (*Langenbeck's*) is undoubtedly the best and the one most frequently practised. Make a vertical incision about five inches long over the back of the joint, beginning about two and a half inches above the olecranon; and carry it over this process and down the ridge on the ulna for the same distance. The incision should extend in its whole length down to the bones. Cut into the joint above the olecranon and clear the condyles of the soft tissues by keeping the edge of the knife in contact with the bone, taking special care not to injure the ulnar nerve behind the internal condyle. Divide the lateral ligaments, and whilst the assistant strongly flexes the joint to force the bones out of the wound, free them from their remaining connections, and saw off the olecranon, the head of the radius, and the lower end of the humerus, steadying the parts with the lion forceps. If possible, the coronoid process of the ulna and the tubercle of the radius should not be removed, and the shaft of the humerus not encroached upon. Preserve the connection of the anconeus with the triceps, as better extension of the arm will be thus obtained. Unite the wound by sutures, after inserting a drain, and place the limb on a splint in the flexed position. Callender's splint is one of the best for the purpose, as it permits of passive motion not only in the direction of flexion and extension, but also in that of pronation and supination, and without removing the arm from the splint. It also allows of the limb being slung by pulleys from the ceiling, which is much more comfortable for the patient than placing it on a pillow. Passive movements should be begun at the end of the first or second week, the aim of the surgeon being to obtain a moveable joint.

THE WRIST may be excised for chronic disease of the wrist and carpal joints. The operation is very successful in suitable cases; these, however, are rarely met with, as if the disease is extensive, it is as a rule better to amputate, and if limited, gouging away the diseased bone will generally suffice. The *operation* usually done is that now known as Lister's. It consists in removing all the bones of the carpus, the bases of the metacarpal bones, and the lower end of the radius and ulna, the incisions being so planned as to avoid cutting the numerous tendons surrounding the joint and the radial artery.

THE HIP may be excised—(1) when the head of the bone has become necrosed, and lies loose in the joint; (2) when suppuration continues in spite of free drainage and antiseptics; (3) when in addition to suppuration the head of the bone is dislocated, and the limb cannot be placed in a useful position. Excision should not be done when there is extensive disease of the pelvis or femur, or signs of lardaceous disease or of phthisis. Under these circumstances amputation is the only resource. For ankylosis in a faulty position subcutaneous osteotomy of the neck of the femur or of the shaft of the bone below the trochanters is preferable to excision. *The operation.*—1. By the *anterior* incision. Make an incision four inches long from half an inch below the anterior superior iliac spine downwards and a little inwards between the sartorius and rectus on the inner side and the tensor vaginæ and glutei on the outer side, and open the joint from the front. 2. By the *posterior* incision. Make a slightly curved incision about four inches long behind the great trochanter, and after dividing the glutei, open the capsule from behind. Whichever incision is made insert the finger into the joint, and with this as a guide, cut through the neck of the femur with Adams's saw, or Gowan's osteotome, and remove the head thus detached with sequestrum forceps. The great trochanter should be spared if possible. It is important to avoid protruding the end of the bone out of the wound since the periosteum may in this way be stripped up and thus lead to further necrosis. Examine the acetabulum, and remove any carious bone or sequestrum that may be discovered with the gouge or sequestrum forceps, and finally scrape away every particle of the tuberculous synovial membrane that can be reached with an aseptic flushing spoon. Place the limb in the position of abduction on a double Thomas's splint, so as to bring the stump of the neck into the acetabulum, and thus leave as little space as possible between the bones. After ankylosis has taken place the abducted position is of advantage, in that to bring the limbs parallel in walking the pelvis will have to be depressed on the affected side, and thus a good inch of lengthening is obtained to compensate for the shortening produced by the excision of the head of the bone. Some surgeons now no longer use a drain-tube, but bring the deeper parts of the wound together by buried sutures, and having lightly closed the skin incision apply firm pressure over a dry antiseptic dressing, so as to keep the tissues in close apposition and thus obtain union by the first intention.

THE KNEE.—Provided none of the contra-indications to excision already enumerated are present, the knee may be excised for intractable disease of the synovial membrane, especially where the articular surfaces are much displaced, or for ankylosis in a faulty position. In the latter instance, however, a subcutaneous osteotomy is often preferable. *The operation.*—The knee being held in a flexed position by an assistant, make an incision from the posterior part of the condyle on one side, across the front of the joint midway between the patella and the tubercle of the tibia, to the corresponding situation on the other. Raise the flap of skin with the subcutaneous tissue thus mapped out, and open the joint by cutting into it above the patella, or the patella may be sawn across and the fragments wired at the end of the operation. Divide the lateral and crucial ligaments, and saw off a thin slice of bone from the lower end of the femur and from the upper end of the tibia, taking care not to injure the popliteal artery which lies close to the back of the joint and is only separated from it by the posterior ligament. If possible, the whole of the epiphysis should not be removed. The wound should then be closed with sutures. A small drain may be inserted on each side, but it is not necessary. Mr. Morrant Baker secured the articular surfaces in contact by means of steel needles fitted with handles. The needles are passed through the skin and obliquely through the bones on each side of the joint, the handles removed, and the needles left *in situ* till union has occurred. Others substitute bone pegs for the needles, passing the pegs along the holes made by the needles. The pegs are then cut off short and left in permanently. Tenotomy of the hamstring tendons may be required to bring the bones into apposition if there has been much displacement. The limb should then be placed in plaster of Paris or on a Gant's or other form of excision-splint; but the kind of splint is not very material if the bones are well secured in good position by the pegs in the way described above. After convalescence the knee should be kept for at least a year in a well-fitting leather splint, as there is a great tendency for the bone to yield and the limb to become flexed. In ankylosis in the semi-flexed position, in place of removing a wedge of bone a curved incision may be made through the bone with Butcher's saw, and the tibia thus slid round the femur into the straight position (Fig. 91). By this method no bone is removed, and the epiphyses being spared there is less danger of a shortened limb. I have obtained excellent results from it in two cases.

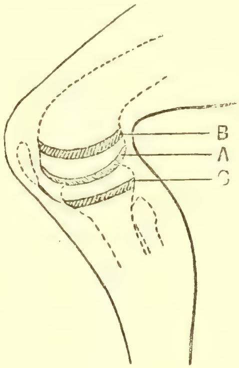


Fig. 91.—Line of incision in the circular division of the femur for ankylosis of the knee in the semiflexed position. A, line of incision; B and C, line of epiphyses.

The ankle.—Excision of the ankle is too rarely required in practice to call for a description. The results following it, moreover, are so unsatisfactory that in disease of the ankle-joint either Syme's operation or amputation through the lower third of the leg is nearly always done in preference. Arthrectomy, however, where the bones are not extensively diseased may be tried before resorting to the above procedures.

DISEASES OF MUSCLES.

INFLAMMATION AND ABSCESS.—Inflammation of muscle, or *myositis*, may be due to a sprain, partial rupture, or other slight injury, or to rheumatism or pyæmia, or it may spread to the muscle from the surrounding tissues. Except in the pyæmic form it generally ends in resolution. *Signs.*—Pain, swelling, rigidity, and more or less fever, followed by signs of an abscess should suppuration ensue. *Treatment.*—Rest, an anodyne liniment or a belladonna plaster to assuage pain, and a free incision if pus forms.

GUMMATA may be met with in muscle in the tertiary stages of syphilis. They are said to be specially common in the sterno-mastoid of infants, the subjects of congenital syphilis; but it is probable that many of the localized swellings in the sterno-mastoid of infants are due to partial rupture during birth.

ATROPHY AND DEGENERATION of muscle merely require mention. The chief degenerations are—1, simple atrophy; 2, fatty degeneration; 3, granular degeneration; and 4, waxy or vitreous degeneration. *In simple atrophy* the muscles merely waste, but do not lose their striation, and are capable of being restored to their normal condition, whereas the fibres of a degenerated muscle are altered in their anatomical structure, and their function is entirely and permanently lost. Simple atrophy may occur from many causes. It is generally seen in surgical practice as the result of long disuse of a limb, as in chronic joint disease, but it is then usually associated with some amount of degenerative change. Fatty, granular, and waxy degeneration, though sometimes met with singly, are more often found combined in the same muscle. They occur in acute febrile diseases, scrivener's palsy, progressive muscular atrophy, infantile paralysis, pseudo-hypertrophic paralysis, &c.

HYPERTROPHY of muscle calls for no special remark. A familiar example of hypertrophy of the *voluntary* muscles is seen in the limbs of athletes; of hypertrophy of the *involuntary* muscles, in the muscular coat of the bladder which has become thickened in its efforts to overcome the obstruction of a stricture.

OSSIFICATION OF MUSCLE may occur as the result of chronic irritation. As examples may be mentioned the *rider's bone*, or ossification of the adductors, occasionally met with in persons who ride a great deal; the *drill bone*, or ossification of the deltoid in soldiers as the result of shouldering arms; and the ossification of the rectus femoris and other muscles in Charcot's disease of the hip-joint.

Myositis ossificans is a rare and chronic disease, usually beginning in boyhood, and seldom seen in females. Masses of bone develop in the muscles, chiefly those of the back, producing deformity, and eventually impeding respiration and so causing death. The disease is generally fatal in about ten years. Its pathology is quite obscure, and no treatment is of avail.

Tumours.—Although primary tumours are not common in muscle, nearly all varieties except carcinoma have at times been met with. Sarcoma occurs, perhaps, the most frequently.

DISEASES OF TENDONS.

Simple teno-synovitis or inflammation of the sheath of a tendon may be acute, subacute, or chronic. It is most frequently met with in the subacute form and in the extensors of the thumb and wrist as the result of over-exertion—a hard day's rowing, and the like. In this situation it produces an elongated swelling over the extensors of the thumb, and is attended with pain on pressure and movement, and a characteristic creaking sensation. In the acute form suppuration may occasionally occur. *Treatment.*—Rest on a splint, painting with tincture of iodine, and strapping will generally suffice. In the acute variety leeches, or free incision if pus forms, and passive movements to prevent adhesions. In the chronic, counter-irritation in the form of blisters, and pressure by means of strapping followed by elastic support.

Ganglion is a simple or compound cyst formed in connection with the sheath of a tendon. It is generally due to continued strain or teno-synovitis. A *simple ganglion* may be produced by—1, the cystic transformation of the cells in the synovial fringes; 2, the dilatation of the sub-synovial follicles; and 3, the pouch-like protrusion of the synovial lining of the tendon through the fibrous sheath, with the subsequent obliteration of the neck of the pouch. × Simple ganglia are most common on the extensor tendons at the back of the wrist, but occur in other situations, as the front of the wrist and ankle, and on the sheaths of the flexor tendons near the web of the fingers. They form smooth, generally globular, often translucent, tense or semi-fluctuating moveable swellings, evidently in connection with a tendon, and varying in size from a pea to a pigeon's egg. They contain a clear jelly-like material. The only inconvenience to which they give rise is a feeling of weakness in the wrist or fingers; they are seldom attended with pain. Simple ganglia are sometimes simulated by pouch-like protrusions of the synovial membrane of the carpus and tarsus. The deep attachment of these synovial pouches, their non-connection with a tendon, and the concomitant swelling of other parts of the synovial membrane are points which may serve to distinguish them. *Treatment.*—They may often be broken by pressure with the thumbs; otherwise they may be punctured with a tenotome, the skin being drawn aside to make the opening valvular, and the contents squeezed out. In either case firm pressure must subsequently be applied by strapping and a bandage. Should they refill, a second puncture may be made, and the interior scarified by the point of the tenotome. This failing, the cyst may be laid open and allowed to granulate from the bottom, or it may be dissected out.

A *compound ganglion* consists of the dilatation of the sheath of several tendons. It is most common in connection with the flexor tendons where they pass under the anterior annular ligament of the wrist, and is then spoken of as the *palmar bursal ganglion*. The walls frequently become thickened and villous-like on their internal surface, whilst *melon-seed-like bodies* are frequently found free in the interior of the ganglion or attached by slender peduncles to its walls. The fluid contained in the cyst may be clear and serous, or thick and gelatinous, and of a dark chocolate colour. These ganglia have lately been described as arising from a tuberculous degeneration of the sheaths of the tendons, similar to pulpy degeneration of a joint, and the tubercle bacillus has been found in some of them. *Signs.*—A palmar bursal ganglion forms a tense elastic swelling, constricted at its centre by the anterior annular ligament. The swelling projects both in the wrist and in the palm, and occasionally extends along the flexor tendons of the thumb and little finger. Fluctuation may be obtained by pressing alternately above and below the annular ligament. Operative *treatment* was formerly, and is now if strict antiseptic precautions are not taken, attended with some risk—such as stiff wrist or fingers from the glueing together of the tendons, suppuration extending up the planes of the flexor muscles into the forearm, acute cellulitis, erysipelas, sapræmia, and pyæmia. An operation, therefore, should only be undertaken when necessitated by loss of power in the wrist or fingers, and even then not until an attempt has been made to cure the ganglion by pressure, strapping, and counter-irritation. Should an operation become requisite, it is best, in my opinion, to make an antiseptic incision above and below the annular ligament, squeeze out the melon-seed bodies and insert a drain-tube. If this is done before suppuration has taken place, recovery with complete movement may generally be obtained. The forearm and hand should be confined on a splint.

Paronychia tendinosa (*Thecal abscess*), a variety of whitlow, is an acute infective inflammation of the sheath of a tendon, generally of a finger, more rarely of a toe. It is usually the result of inoculation with a septic or infective poison in a person who is out of health. It may begin in the sheath of the tendon, or in the tissues superficial to the sheath, or in the periosteum of the phalanx. If neglected, very serious consequences may ensue; thus—1, the tendon may die from its blood-supply being cut off by the inflammatory effusion; 2, the suppuration may extend into the palm, and under the annular ligament into the forearm; 3, the inter-phalangeal, carpal, or wrist joint may become involved in the inflammation and destroyed; 4, the phalanx may necrose; 5, septicæmia or pyæmia may ensue. *Signs.*—Intense and throbbing pain, acute tenderness on pressure, and swelling and induration of the finger, followed by a similar condition of the palm, and often by great œdema of the back of the hand, which may perhaps extend up the forearm. The lymphatics may become tender and inflamed, and the lymphatic glands in the axilla enlarged. Exhaustion from pain and want of sleep, feverish symptoms, and at times signs of blood-poisoning may ensue. *Diagnosis.*—Acute septic inflammation of the pulp of the finger is very apt to be mistaken for true thecal whitlow. The diagnosis of these two conditions is most important, since in the former affection if free incisions are made into the inflamed part, leaving the tendon sheath intact, the tendon will be saved, whereas if the affection is mistaken for thecal abscess, and the sheath opened, the septic material will invade the sheath, and the tendon will probably be destroyed. The history of the case and the severity of the symptoms will guide us somewhat, but perhaps the most important sign in distinguishing the two affections is one pointed out by Mr. Morrant Baker, viz., "the power or the loss of it on the part of the patient of flexing voluntarily the distal phalanx." In true thecal whitlow this power is much impaired or lost, whilst in mere septic inflammation of the pulp, although the finger may appear hopelessly spoiled, it is "markedly and strongly retained." *Treatment.*—The chief indication is to relieve tension, and thus prevent the strangulation of the vessels and subsequent death of the tendon, and the spread of the inflammation into the palm or to the periosteum covering the phalanx. For this purpose a free incision is generally recommended in the middle line of the finger extending into the sheath, or to the bone if the periosteum is affected. Mr. Heath, however, advises that the incisions should be made at the side of the finger, but should not in this position open the sheath, since if this is done he says the tendon invariably sloughs. He opens the sheath by a small incision through the palm over the head of the metacarpal bone. Should suppuration occur in the forearm the pus of course must be let out by timely incisions. The pain in the meanwhile will be greatly relieved by placing the whole forearm for several hours at a time in a bath kept at a temperature as high as can be borne. Corrosive sublimate or carbolic acid should be added to the water. A purge at the onset is generally required, and opium is usually needed to relieve the pain. The patient at first should be confined to a slop diet, but later a stimulating plan of treatment is commonly called for. Should any stiffness of the part remain after the inflammation has subsided, an attempt should be made to overcome it by passive movements, massage, &c. Dead bone must be removed when loose, and amputation of the affected finger, or even, in severe cases, of the forearm, may become necessary.

DISEASES OF FASCIÆ.

DUPUYTREN'S CONTRACTION of the palmar fascia is the only affection of the fasciæ requiring notice. It has been attributed to gout and rheumatism, and to habits or occupations necessitating pressure in the palm, or flexion of the fingers. It is probably of the nature of a chronic inflammation, secondary, according to Mr. Anderson, to inoculation of the subcutaneous connective tissue with a specific germ which he suggests might gain admission by a scratch of the palm by the finger-nail. The affection consists in a shortening of the prolongations of the fascia from the palm on to the sheath of the flexor tendons. The tendons themselves are not affected. The contraction generally begins in the fascia of the little or ring finger as a small rounded fibrous nodule, and always at a point where a wound from the nail with the finger clenched might occur, and later may affect that of the middle finger, and at times the forefinger and also the thumb. The affected fingers (Fig. 92) are drawn by tense bands towards the palm, and in severe cases may become fixed in contact with it. The skin being adherent to the fascia, is thrown thereby into transverse puckers. The affection may be distinguished from a contracted tendon by the latter forming a tight cord, which can be traced under the annular ligament, and by the skin in the case of the contracted tendon being free. In contraction of the fascia, moreover, two tense bands can generally be traced to the sides of the finger, whereas a contracted tendon is centrally placed.

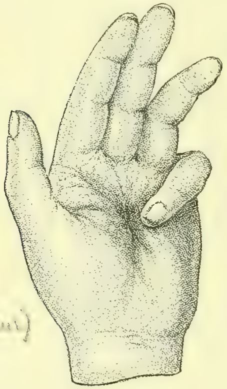


FIG. 92. — Dupuytren's contraction of the palmar fascia. (From a cast in St. Bartholomew's Hospital Museum.)

Treatment.—Except in the early stages, when steps should be taken to prevent further contraction by suitable splints, elastic tension, &c., subcutaneous division of the affected portions of the fascia, followed by extension, or the excision of the contracted band through an open aseptic incision (*Hardie's method*) is requisite. Subcutaneous division may be done by single or by multiple puncture. The latter is, in my opinion, preferable if the subcutaneous method is adopted. The punctures should be made opposite the puckers in the skin, not in the creases, to prevent the wounds from gaping when the fascia is stretched. An apparatus should be worn for many months to prevent recontraction. In severe cases I have obtained excellent results by the open incision. After this method, moreover, there is less liability to recontraction.

DISEASES OF BURSÆ.

Bursæ, wherever situated, and whether existing naturally or formed adventitiously, are liable to become acutely or chronically inflamed.

Acute bursitis may occur spontaneously, but is generally excited by injury, or undue pressure as from constant kneeling. The inflammation comes on rather suddenly, the part appearing red, hot, and swollen. It is apt to terminate in suppuration, which if timely incisions are not made may become diffuse and phlegmonous. Evaporating lotions, an ice-bag or a few leeches, may, if applied early, check the inflammation; but a free incision must be made as soon as there are signs of suppuration.

Chronic bursitis is very apt to occur in bursæ that are subjected to continued pressure or irritation, and may lead to several distinct conditions. Thus, 1. *Bursæ may become simply enlarged and distended with bursal secretion.* In this state they form globular, fluctuating, often translucent, tense or flaccid swellings; their walls are but slightly thickened; and there is no heat or redness of the skin. 2. *They may become enlarged, slightly thickened, and distended with a serous or dark fluid containing small masses of fibrin resembling melon-seeds.* These melon-seed bodies may be formed from extravasated blood, fibrinous deposits, or detached portions of thickened synovial fringes, and their presence may sometimes be detected by the crackling sensation they give when the bursa is handled. Sometimes in place of, or together with, melon-seed bodies, fibrous cords are found stretching across the cavity of the bursa. 3. *They may become enlarged and their walls greatly thickened by inflammatory infiltration and the deposit of fibrin in their interior.* A small central cavity may remain, or they may be solid throughout. They then appear as firm, non-elastic, solid-feeling tumours, and when situated over the tuberosity of the ischium, or in front of the patella, may cause much inconvenience.

Treatment.—When simply enlarged, painting with the liniment of iodine, or strapping, will sometimes disperse them. If this fails they should be punctured, the fluid evacuated, the melon-seed bodies, if present, squeezed out, and firm pressure applied. When greatly thickened or solid they must be dissected out.

The *situations* in which these various conditions of the bursæ are most frequently met with are:—over the patella, the *housemaid's knee;* over the olecranon, the *miner's bursa;* over the tuber ischii, the *weaver's bottom* or *coachman's bursa;* over the great trochanter; under the semi-membranosus; and under the psoas tendon. Adventitious bursæ may also be found under corns or over points of bone subjected to pressure, as the metatarso-phalangeal joint of the great toe (*bunion*), the outer side of the foot in talipes varus, &c. (See *Hallux Valgus* and *Talipes.*)

The *bursa patellæ* is the one which is most frequently affected, and what has been said about diseases of bursæ in general applies particularly to it. When acutely and diffusely inflamed it may simulate disease of the knee-joint, from which, however, it may readily be diagnosed by the swelling in the one case being in front of the patella and in the other behind it. A few words may also be added concerning the *bursa beneath the semi-membranosus.* When enlarged it forms a tense or semi-fluctuating ovoid swelling in the popliteal space, but becomes flaccid or disappears altogether on flexing the knee. Counter-irritation or pressure will generally disperse it. If these fail it may be punctured or incised and drained antiseptically; but the greatest precaution must be taken to prevent septic changes occurring, as it often communicates with the knee-joint. Indeed, I have seen several cases in which acute suppuration in the knee, necessitating amputation, has followed the incautious puncture of these bursæ. The safest course perhaps is to dissect out the bursa, ligature the pedicle by which it communicates with the knee-joint, and cut the rest away.

[illegible]

DISEASES OF THE ARTERIES.

[illegible] p 37

[illegible] cap patellar

ARTERITIS OR INFLAMMATION of the arteries may be *acute* or *chronic.*

ACUTE ARTERITIS was formerly thought to be of frequent occurrence as an *idiopathic* affection, but as such it is now known not to exist. *Acute traumatic arteritis*, however, is very common, occurring as it does in the *simple* or *plastic* form in the process of healing of an artery after injury or ligature, or from the presence of a non-infective thrombus; whilst as a *septic, infective,* or *suppurative* affection it is occasionally met with as the result of the extension of septic or infective inflammation to an artery from the surrounding tissues, or as the result of the presence of a septic or infective embolus brought by the blood-stream from a like inflammation of a distant part, as the heart in ulcerative endocarditis.

Plastic or adhesive arteritis has already been discussed under the *Healing of Arteries.* Of *septic and infective arteritis* all that need be said here is that when due to extension from the surrounding tissues it may lead to the softening and giving way of the arterial walls, and, unless a clot forms above and below, to hæmorrhage; whilst when due to an embolus it may lay the foundation of an aneurysm, or more rarely, may lead to the rupture of the vessel. It is believed to be the chief cause of aneurysm in children.

CHRONIC ARTERITIS, familiarly known as *atheroma*, mainly affects the deeper layers of the intima, not, as a rule, the other coats. Hence it is often spoken of as *endarteritis.* It is the commonest disease of the arteries, and to some extent is generally present in persons over forty. It is most frequent in the aorta and large vessels, that is, in those containing the greatest amount of yellow elastic tissue, and is more often met with in the arteries of the lower than in those of the upper limb.

Causes.—Mechanical strain or vascular tension is looked upon as the most frequent *exciting* cause. Thus it is attributed to—1, occupations necessitating severe and prolonged exertion; 2, the abuse of alcohol, which produces an increased and forcible action of the heart; 3, chronic Bright's disease, in which the blood-pressure, in consequence of capillary fibrosis or spasm of the arterioles, is increased; 4, plethora, in which the arterial tension is also raised; 5, syphilis, which is attended by fibroid change in the small vessels and consequent increased vascular tension; and 6, gout, in that it may produce Bright's disease. In addition, however, to the increased vascular tension, to which the above-mentioned conditions may give rise, gout, syphilis, and alcohol may also lead to primary degenerative changes in the coats of the arteries in common with the degenerations they induce in the tissues generally throughout the body, and hence, together with advancing age, and the male sex, men being more exposed to mechanical strains than women, may be looked upon as *predisposing* as well as exciting causes.

Pathology.—Arteritis begins as a small-round-cell infiltration of the deeper layers of the intima—those next the muscular coat. This gives rise to characteristic greyish-white, slightly-elevated, tough, semi-gelatinous patches on the inner surface of the vessel. The patches, which frequently begin around the entrance of small lateral branches, increase by their edges, and by coalescing with other patches, produce extensive tracts of the disease. The inflammatory infiltration in consequence of the absence of new vessels, may undergo—1, fatty; 2, calcareous; or 3, fibroid degeneration. 1. The patches formerly grey become yellowish-white, breaking down into a cheesy mass or completely liquefying into a puriform fluid consisting of fatty *débris*, cholesterine-crystals, and minute oil-drops. The layers of the intima next the blood are at first continued unbroken over the fatty patch, which is then called an *atheromatous abscess*. These layers, however, may subsequently give way, leaving the softened and fatty mass in contact with the blood (the *atheromatous ulcer*). Portions of the fatty material may now be washed away by the blood-stream and become lodged in some of the smaller arteries and capillaries, where they seldom, however, do any harm, as the emboli are non-infective. At times, however, a larger vessel may become plugged, when gangrene may ensue. As the atheromatous material is washed away by the blood, fibroid thickening of the external coat and sheath of the artery takes place opposite the base of the ulcer, so preventing perforation of the artery; but as the new tissue is very inelastic it is liable to yield to the pressure of the blood and an aneurysm occur. 2. Instead of the patch undergoing fatty softening, lime salts may be deposited in it. This *secondary* calcification must be distinguished from the *primary* calcification to be shortly mentioned. The intima may be continued over the calcareous patch, or it may break away, leaving it exposed to the blood current, thus constituting a nidus for the deposition of fibrin and the formation of a thrombus, portions of which again in their turn may be washed away by the blood and form emboli. 3. The small-cell-infiltration in the inflamed patch instead of undergoing either of the former changes may advance to the production of fibrous tissue, and dense fibroid thickening result.

The effects of chronic arteritis.—1. The artery may become dilated, elongated, and tortuous; 2, it may yield at the atheromatous patch, producing an aneurysm; and 3, it may rupture under violence. In addition to the above effects depending upon the loss of elasticity of the vessel, thrombosis and embolism may occur as already stated, and give rise to gangrene, aneurysm, or rupture.

Signs.—Except in the superficial vessels, where atheroma is productive of rigidity and a tortuous condition of the artery, it gives no special evidence of its presence.

SYPHILITIC ARTERITIS is the term applied to a fibroid change occurring chiefly in the smaller arteries during the later stages of syphilis. It is most common in the arteries of the brain. The change consists in an extensive infiltration of small round cells, which later become developed into an imperfect fibrous tissue. The inner coat is chiefly affected, and becomes greatly thickened, so that the lumen of the vessel is almost or entirely obliterated. The outer coat is likewise implicated, but to a less extent, while the muscular coat either escapes, or is merely encroached upon by the cells infiltrating the inner coat. The disease is very chronic, and may terminate in thrombosis, or may lead to the formation of an aneurysm.

OBLITERATIVE ARTERITIS, so called, is a rare disease, characterized by great pain spreading up the course of the artery, loss of pulse in the vessel, and often gangrene of the part supplied by it. Its pathology is not known, but there is evidence that points to its depending more on some nerve change than on an inflammation of the artery itself.

PRIMARY DEGENERATION OF ARTERIES.—We have already seen that fatty, calcareous, and fibroid degeneration may follow chronic endarteritis. These changes may, however, occur as primary affections, and may next be considered.

Primary fatty degeneration begins in the superficial layers of the intima, immediately under the endothelium. It takes the form of yellowish-white patches, very slightly projecting into the vessel. The patches can be readily stripped off from the deeper layers, which when thus exposed are found healthy; whereas, in atheroma, it is the deeper layers which are the seat of the disease. The disease is attended with no signs, and is of little practical interest.

Primary calcification is of more importance. It should be distinguished from calcification occurring as a secondary change in endarteritis. Primary calcification begins in the circular muscular fibres of the middle coat, and is more common in the smaller than in the larger arteries, and in those of the lower than in those of the upper extremity. It is a disease of advancing age, and is a frequent cause of senile gangrene in that the arteries are converted into rigid tubes and the circulation through them is in consequence greatly impeded. Thrombosis, moreover, is very liable to occur. In primary calcification the lime salts are deposited in the form of rings (Fig. 93) instead of in irregular patches as in secondary calcification.

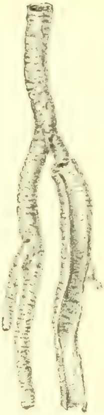


FIG. 93.—Primary calcification of arteries. (St. Bartholomew's Hospital Museum.)

Fibroid degeneration.—For a description of this a work on Medicine must be consulted.

ANEURYSM.

An aneurysm is a tumour containing blood and communicating with the interior of an artery. Aneurysms may be divided into two main classes, the *spontaneous*, which are the result of disease of the arterial walls, and the *traumatic*, which are due to a direct injury of the artery and extravasation of blood into the tissues. Here the spontaneous only will receive attention. The traumatic are described under Injuries of Arteries (p. 192).

SPONTANEOUS ANEURYSM.—*Cause.*—Aneurysms are most common at that age when the coats of the arteries are liable to be weakened by disease whilst the muscular system is still vigorous, and are chiefly met with among those whose occupations subject them to sudden or irregular strains. Hence the frequency with which they occur in soldiers, sailors, and the labouring classes, and in men rather than in women. The chief *predisposing causes* are—1, *atheroma*, whereby the coats of the artery are softened and unable to resist an increased expansile pressure of the blood; and 2, *embolism*, which may lead to inflammatory changes, and consequent weakening of the arterial walls immediately above the embolus. Thus the conditions which induce atheroma and embolism may also be considered as predisposing causes of aneurysm. Of these, however, syphilis, the abuse of alcohol, continued vascular strain, and ulcerative endocarditis may be especially mentioned. Syphilis is by far the most common cause of aneurysm in women. The *exciting causes* are such as produce the rupture or yielding of the diseased coats, either (*a*) by direct mechanical violence, or (*b*) by increased blood-pressure in the vessel owing to violent and sudden action of the heart and obstruction by muscular contraction of the capillary flow. Hence, blows or strains, mental emotion, and violent and sudden exertion of all kinds may be mentioned as exciting causes.

Process of formation.—An aneurysm may be formed in several ways:—1. By the simple dilatation of a diseased portion of an artery due to the yielding of the softened coats to the expansile force of the blood current. 2. By the giving way of the internal and middle coats at the diseased spot, and the yielding of the external coat to the force of the blood. This is the commonest way in which an aneurysm is formed—the elastic fibres of the internal coat as the result of the atheroma soften and break down, the middle coat gives way, and the external coat, unable to resist the blood-pressure, is bulged out, forming the sac of the aneurysm. 3. By the giving way of all the coats at the diseased spot and escape of the blood into the tissues which become condensed around it to form a sac. 4. By the giving way of the external and middle coats, and the protrusion of the internal coat through them (very rare); and 5. By the giving way of the internal and part of the middle coats, and extravasation of the blood between the layers of the middle coat.

Structure of an aneurysm.—An aneurysm consists of a sac and its contents. *The sac* may consist—(1) of all the coats of the artery, Fig. 94, A and B; (2) of the external coat only, Fig. 94, C; (3) of condensed tissues external to the artery, Fig. 94, F; (4) of the internal coat only (very rare), Fig. 94, D; (5) of the separated layers of the middle coat, between which the blood has been forced, with the external and internal coats on either side (dissecting aneurysm), Fig. 94, E. The practical point, however, to be borne in mind, is that it is only while the aneurysm is small, and then by dissection alone, that these distinctions can be made; and that as the aneurysm increases in size the tissues around become condensed and blended with the sac, which may finally be formed almost or entirely of these tissues. *The contents of the sac.*—When an aneurysm is first formed, the sac only contains fluid blood; fibrin, however, is gradually deposited from the blood in concentric layers upon the internal surface of the sac, so that after it has existed some time, the contents are partly solid laminated fibrin, and partly coagulated and fluid blood. Next the wall of the sac the fibrin is laminated, firm and compressed, and of a yellowish-white colour; but towards the mouth of the sac it becomes softer and moister, and of a reddish colour; whilst that in contact with the fluid blood merely resembles ordinary blood coagulum. In an aneurysm that has been cured, the whole sac will generally be found thus filled with laminated clot, which has been aptly likened to the appearance presented by the section of an onion (Fig. 95). Where the cure has taken place in a few hours, it is probable that the greater part of the material filling the sac is merely blood coagulum, as in such instances the time would probably be too short for fibrin to be deposited.

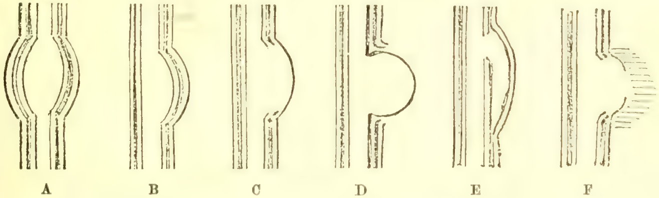


FIG. 94.—Diagram illustrating the structure of an aneurysm.

CLASSIFICATION.—Spontaneous aneurysms may be divided into the fusiform, the sacculated, and the dissecting.

1. *A fusiform aneurysm* is a dilatation of the whole circumference of a portion of an artery. The sac consists of all three coats, and is continuous with the lumen of the artery at each end (Fig. 94, A). The dilated portion of the artery is also elongated, as is well seen in aneurysms of the arch of the aorta, where, in consequence of such elongation, the three primary branches are much further apart than normal (Fig. 95). Fusiform aneurysms are most common in arteries that contain much yellow elastic tissue, as the aorta and its primary branches and the contiguous portions of the iliac and femoral arteries. They often attain a large size, and after they have existed some time frequently become sacculated from the unequal yielding of their walls. The walls themselves, though sometimes thinned, are more often thickened, and are highly atheromatous. Laminated fibrin is seldom found in them,

as the circulation does not as a rule become sufficiently retarded to allow of its deposition.

2. *A sacculated aneurysm* is one in which dilatation occurs in part of the circumference of the artery only (Fig. 94, B, C, and D). It may consist of all three coats; but much more often the internal and middle coats give way, and it is formed of only the external coat, or after it has existed some time, chiefly of the condensed cellular tissue around. According as all three coats are or are not present, the aneurysm was formerly spoken of as *true* or *false*. As, however, it is only the smallest aneurysms that can consist of all three coats, the true aneurysm could hardly be said ever to occur, and all sacculated aneurysms were then called false—the absurdity of which is self-evident. As these aneurysms increase in size, the sac comes to consist almost entirely of the tissues around. Whilst they are still enclosed by one of the coats of the artery, they are sometimes called *circumscribed*, and after all the coats have given way, *consecutive or diffused* (Fig. 94, F). As the term diffused, however, is sometimes applied to a leaking or ruptured aneurysm, it had better be discontinued. Nearly all sacculated aneurysms, when they have existed some time, are of the consecutive variety, and usually contain a considerable amount of laminated fibrin.

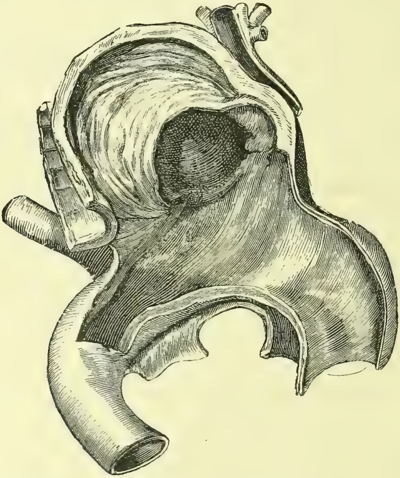


FIG. 95.—Laminated appearance of the clot filling a consolidated aneurysm of the arch of the aorta. (St. Bartholomew's Hospital Museum.)

3. *A dissecting aneurysm* is one in which the internal coat of the artery and part of the middle coat have given way, and the blood

has been forced between the two layers of the middle coat for a variable distance parallel to the course of the artery (Figs. 94, E, and 96). It is most frequent in the arch and thoracic portion of the aorta. The blood may remain between the layers of the middle coat, or it may escape through a rupture of the external coat into the tissues around, or through a rupture of the internal coat lower down the course of the vessel into the lumen of the artery.

TERMINATIONS.—An aneurysm may terminate in spontaneous recovery or in death.

Spontaneous recovery may take place :—A. *By the gradual deposit of fibrin from the blood in a laminated manner* on the walls of the sac, so that the aneurysm is completely consolidated (Fig. 97, A), and subsequently by condensation and shrinking becomes converted into a small nodular mass of fibrous tissue. The artery under such circumstances may remain pervious, or become converted into a fibrous cord as far as the first

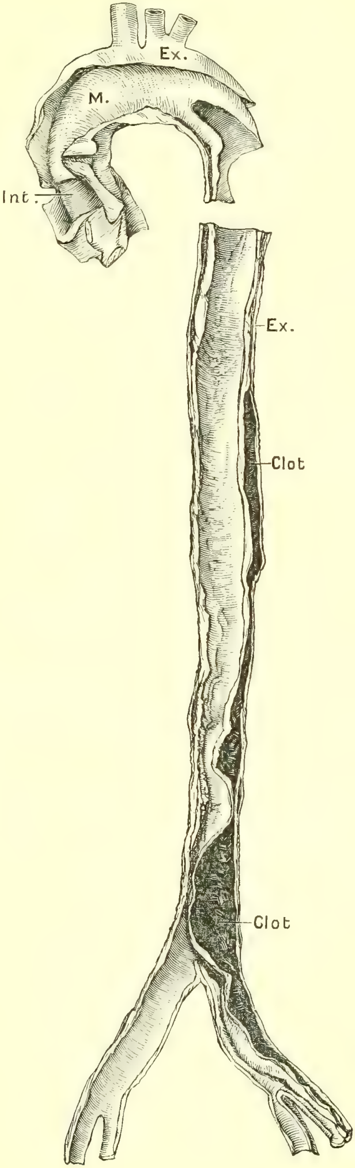


FIG. 96.—A dissecting aneurysm of the aorta. The internal and middle coat have given way one inch above the valves, and the blood has separated the outer coat from the middle the whole length of the aorta, and has extended between the coats of the left common and external iliac. EX. External coat, M. middle coat, INT. internal coat. (St. Bartholomew's Hospital Museum, No. 1464, *a* and *b*.)

collateral branch above and below the seat of the aneurysm. Such a favourable termination may be brought about by the retardation of the blood current induced by—(1) the lowering of the heart's action; (2) the pressure of the aneurysm on the artery above its opening into the sac (Fig. 97, C); (3) the *partial* blocking of the mouth of the sac with a piece of detached coagulum; (4) the impaction of a piece of clot in the artery below the mouth of the sac (Fig. 97, B); (5) the pressure of another aneurysm or of a tumour upon the artery above the sac or on the sac itself; (6) the aneurysm rupturing, and the effused blood compressing the artery leading to the aneurysm. B. *By the filling of the sac with ordinary coagulum, the passive clot* as it is called, in contradistinction to the deposit of laminated fibrin (*the active clot*). This coagulation of the blood in the sac may be brought about by—(1) the *complete* blocking of the mouth of the sac by a piece of detached clot (Fig. 97, D), or (2) the complete plugging of the artery above and below the aneurysm. The clot may then undergo the ordinary changes that occur in the so-called organization of blood-clot and be converted into fibrous tissue. C. *By the inflammation and sloughing of the sac* and the plugging of the artery above and below with clot and the subsequent changes described under the spontaneous arrest of hæmorrhage.

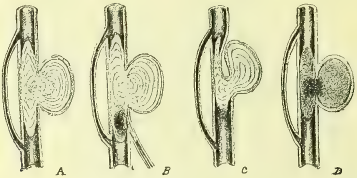


FIG. 97.—Diagram to show methods of spontaneous cure of aneurysm. A. by laminated fibrin (*active clot*), B by plugging of artery below, C. by pressure of aneurysm on artery above mouth of sac, D. by plugging of mouth of sac and formation of ordinary coagulum (*passive clot*).

A fatal termination may be brought about by—1, rupture of the sac; 2, inflammation and sloughing of the sac attended by hæmorrhage; 3, pressure upon important parts; 4, gangrene due to the obstruction to the circulation in consequence of the large size of the aneurysm, or to the plugging of a large vessel by a portion of detached clot; 5, general constitutional disturbance. Rupture when it occurs into a serous cavity is generally by a rent or fissure; into a mucous canal, by a small round ulcerated opening; on to a cutaneous surface, by sloughing of the skin covering the sac. In the first case the rupture is generally rapidly fatal from excessive hæmorrhage; in the last two, as a rule, only after repeated hæmorrhages, the slough having at first a tendency to cause the coagulation of the blood and block the opening.

Pressure effects.—The pressure of the sac of an aneurysm may cause—1, inflammation and condensation of the parts around, which thus become blended with the sac; 2, diminution or obliteration of the lumen of a large vein; and hence 3, œdema and dilatation of the superficial veins; 4, irritation or interruption of the conducting power of nerves giving rise to pain, spasm, or paralysis; 5, erosion of the bones and cartilage; 6, obstruction of the œsophagus, trachea, or thoracic duct.

Effects on the circulation.—Hypertrophy of the left ventricle of the heart; obstruction of vessels and enlargement of the anastomotic channels; syncope, and gangrene.

SYMPTOMS AND SIGNS OF EXTERNAL ANEURYSM.—The attention is usually first drawn to the disease by pain, swelling, and a feeling of muscular weakness, or by a stiffness in a joint. On examination a tumour is discovered in the course of the main artery. It pulsates, and the pulsation is *expansile*, that is, on placing the hand upon the aneurysm, it is felt at each systole of the heart to enlarge in every direction, or if the hands are placed on either side of the tumour, they are seen to be slightly separated at each pulsation. If the artery on the cardiac side of the tumour can be compressed, the pulsation of the tumour is felt to cease, and the tumour itself to become perceptibly smaller and less tense. On cessation of the pressure, however, it quickly fills again in two or three forcible pulsations, and resumes its former characters. On raising the limb the pulsation is less forcible; on lowering the limb more forcible, the tumour at the same time becoming more tense. The pulse below the tumour is smaller on the affected than on the sound side, and a sphygmographic tracing, if taken, shows the pulse is delayed on the diseased side and diminished in force, the tracing being less abrupt in its rise and more rounded (Fig. 98, B). On listening with the stethoscope, a bruit is heard in most cases. In consequence of pressure on the vein corresponding to the artery, there is often œdema of the part below, and sometimes varicosity of the superficial veins.

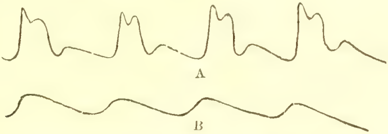


FIG. 98.—Sphygmographic tracing of the pulse in an artery below an aneurysm (B) compared with that of the pulse on the sound side (A). (After Mahomed.)

In *internal aneurysms*, no tumour may be felt; the signs are then often obscure, and the diagnosis will depend upon the effects the aneurysm produces by pressing upon important parts. Thus in thoracic aneurysms, there may be pain, dyspnœa, dysphagia, cough, aphonia, dilatation of the pupil on one side, enlargement of the superficial veins, and œdema of one arm; signs readily explainable by the pressure on the nerves, trachea, bronchi, œsophagus, and arteries and veins of the thorax. But for a more detailed account of the symptoms of internal aneurysm, a work on Medicine must be consulted.

The signs of an aneurysm undergoing spontaneous cure are usually obvious. The tumour decreases in size, becomes harder, and the pulsation in it gets gradually less and finally ceases. At times a rapid cure may ensue; the pulsation then ceases suddenly, and the tumour is felt to be hard, the patient often complaining of great pain at the moment of consolidation.

The signs of a leaking aneurysm, *i.e.*, an aneurysm in which blood is beginning to be slowly effused into the tissues, are as follows:—The pulsation is less distinct, the outline of the tumour less circumscribed, the growth progressive, and the pressure-signs are more urgent.

The signs of sudden rupture of an aneurysm.—1. If the rupture is into a serous cavity, the signs are those of internal hæmorrhage, rapidly followed by death. 2. If into a mucous canal there will be sudden hæmoptysis in the case of the trachea or bronchus, hæmatemesis in the case of the œsophagus or stomach, melæna, if the patient lives long enough, in the case of the intestines. 3. If the blood is effused into the tissues, there will be pain, faintness, loss of pulsation and bruit, rapid increase in the size of the swelling, œdema, coldness, and cessation of the pulse in the parts below, followed by increasing syncope from loss of blood, or if death does not soon occur, by gangrene. 4. Rupture externally is very rare; the signs are evident.

DIAGNOSIS.—An aneurysm may have to be diagnosed from simple dilatation of an artery, an abscess or tumour over an artery, a pulsatile tumour of bone, and enlargement of the thyroid gland. In a *simple dilatation*, there is an absence of bruit. In an *abscess or tumour over an artery*, the pulsation is not expansile, there is no bruit, and the swelling is not emptied or made less tense on compressing the artery above. A *tumour* can often be lifted from the vessel. In the case of an *abscess*, there will probably be a history or signs of previous inflammation. In a *tumour raising an artery over it*, the pulsation is only felt in the course of the artery, and there is no expansile pulsation in the swelling. In *pulsatile tumour of bone*, the pulsation is not equally expansile all over; and although pulsation is stopped on compressing the artery above, the swelling does not become smaller like an aneurysm, or refill on removal of the pressure in two or three beats of the heart. Portions of expanded bone may also be felt in parts of the tumour, and there may be glandular enlargement and other signs of malignancy. From an *enlarged thyroid gland*, a carotid aneurysm may be distinguished by the gland moving with the larynx on deglutition. In very rare instances there may be no pulsation in an aneurysm. I have met with such a case myself. The diagnosis from a solid tumour is then very difficult if not impossible without an exploratory incision.

TREATMENT.—In no disease, perhaps, has an accurate knowledge of its pathology done more to ensure success in treatment than in aneurysm. The older surgeons, believing that the clot possessed vicious properties, directed their efforts to the emptying of the sac; and it was not until the fact became fully recognized that Nature's method of curing an aneurysm was by filling the sac with organizable clot, that the lamentable results attending the treatment of aneurysm in olden times gave place to the brilliant successes of modern surgery. The treatment at the present day is therefore directed rather to aiding or promoting Nature's efforts than to thwarting them. Thus, the modern surgeon, by means of rest, low diet, recumbency, and certain medicines, endeavours to lessen the force of the blood-current through the sac, and thus to aid Nature in the deposition of laminated fibrin. By compression or ligature of the artery between the aneurysm and the heart he aims at diminishing the flow of blood through the artery leading to the aneurysm, and in this manner seeks a like result. By *manipulation* and the use of the *distal ligature*, he endeavours to copy the method of spontaneous cure that is sometimes brought about by the plugging of the artery beyond the aneurysm; by *flexion*, he imitates Nature's method of cure by the pressure of the aneurysm itself on the artery either above or below the sac; whilst by *excision* he may be said in a sense to adopt the occasional method of spontaneous cure seen in the sloughing away of the whole aneurysm. The treatment of aneurysm, therefore, may be divided into the medical or general, and the surgical or local.

Medical treatment.—Both internal and external aneurysms have been cured by medical treatment alone. Indeed, in some forms of internal aneurysm, it is the only means at our command. In external aneurysms, however, local treatment in addition is nearly always expedient or necessary. Absolute rest, both bodily and mental, should be enjoined; the patient must lie in bed, and must not move for any purpose whatever, not even to feed himself. The diet should be limited in quantity, unstimulating but nutritious in quality, and the fluid portion restricted as much as possible. The following diet scale is advised by Mr. Jolliffe Tufnell:—Bread and butter, 4 ozs.; meat, 3 ozs.; potatoes, 3 ozs.; fluid, 8 ozs. in the twenty-four hours. Small repeated bleedings, where there is excessive action of the heart, or the patient is plethoric, may occasionally be useful. Medicines seem to have little efficacy, but iodide of potassium in large doses, acetate of lead, aconite, and digitalis have been recommended, either for promoting the coagulation of the blood or retarding the heart's action. Where there is a history of syphilis, iodide of potassium should certainly be given.

Surgical treatment.—In all suitable cases of external aneurysm pressure, when it can be applied between the aneurysm and the heart, should first be tried, aided under certain circumstances by the method of flexion. But these failing, or appearing unsuitable, the artery should be tied, if practicable, on the proximal side, or the whole aneurysm may be, under certain circumstances, excised. Where pressure or ligature cannot be used on the proximal side, as, for instance, in aneurysms at the root of the neck, it becomes a question whether we should try distal pressure or ligature, scratching the wall with needles (*Macewen's method*), manipulation, galvano-puncture, coagulating injections, or the introduction of wire or horsehair; or fall back on medical means alone. In some varieties of traumatic aneurysm, and in certain forms of aneurysm, as gluteal, where a ligature of the artery at a distance from the sac is attended with excessive risk, it may even be expedient to resort to the old method of opening the sac, turning out the clot, and securing both ends of the bleeding vessel by ligature. Each of these methods requires discussion. Before resorting to surgical methods, however, the circulation through the aneurysm should have been previously quieted as much as possible by rest, recumbency, restriction of the diet, and regulation of the secretions. Where the aneurysm is on an artery of the lower extremity, any embarrassment of the venous circulation and consequent œdema that may be present should be lessened or removed by elevating and lightly bandaging the limb.

Pressure.—This method of treating aneurysm was known to the older surgeons, but in consequence of their efforts being directed either to the emptying of the sac by direct pressure upon it, or to the obliteration of the artery leading to it by adhesive inflammation, it was attended with such unfavourable results that it fell into disuse. To the Dublin surgeons, who recognized the fact that it was not necessary to obliterate the artery in order to cause consolidation of the aneurysm, is due in chief part the credit of reviving treatment by pressure. The object of pressure as now employed is to produce consolidation of the aneurysm by the formation of either a laminated or an ordinary coagulum. The methods of bringing this about may be considered under 1, direct pressure on the aneurysm; and 2, indirect pressure, either on the artery above, on the artery below, or on both simultaneously.

1. *Direct pressure* is now seldom used, except in as far as flexion may be considered as in part a method of direct pressure, although several successful cases have of late been reported. It will not receive further notice.

2. *Indirect pressure*, whether applied to the artery above, the artery below, or to both at the same time, may be considered under the heads of—(*a*) Digital pressure. (*b*) Instrumental pressure. (*c*) Pressure by Esmarch's bandage. (*d*) Pressure by flexion of the limb.

(*a*) *Digital pressure*, where it can be applied to the artery on the proximal side at some distance from the sac, is undoubtedly the safest and probably best method of treating an aneurysm; and it is the one, other things being favourable, which should usually first be tried. There are some surgeons, however, who, now that the healing of the wound for the ligature of an artery can practically be assured by the first intention, prefer ligature to pressure as the more certain though perhaps the more risky method. The advantages claimed for digital pressure are—1, that it causes less pain than other forms of pressure; 2, that the artery can be compressed with little or no interference with the venous circulation; 3, that it is less liable to injure the tissues; and 4, that in common with other methods of pressure, it does not expose the patient to the dangers of an open wound. Pressure treatment requires a relay of intelligent assistants, acting in pairs and alternately compressing the artery for about ten minutes at a time. Whilst one presses the artery, the other should have his hand on the aneurysm, to ascertain if pulsation is being properly controlled. The fingers of the one assistant should not be removed till the other has taken his place, as the artery must on no account escape compression for a single moment. The pressure of the fingers may be aided by a shot-bag, and the spot at which pressure is applied may be slightly varied from time to time. Opinions differ as to whether the circulation should be completely, or only partially, stopped through the artery, and whether the pressure should be continued both day and night, or only during the day. Aneurysms have been cured by digital pressure in a few hours, but some days are usually necessary; and to obtain success, much care and attention to detail is required.

(*b*) *Instrumental pressure* may be applied so as only partially to control the circulation through the artery, and thus induce the gradual obliteration of the aneurysm by the deposit of laminated fibrin in the sac (*slow pressure*); or it may be applied so as to completely control the flow of blood through the vessel, and induce rapid coagulation in the sac (*rapid pressure*). The latter method can only be done under an anæsthetic, but has been attended with some brilliant results, especially in cases of abdominal aneurysm. As a rule for external aneurysms, however, the milder measures will suffice, and it is a question if these fail whether it is not better treatment to ligature the artery than subject the patient to further attempts at cure by rapid pressure. Both kinds of pressure may be applied by one or other of the many forms of compressors and tourniquets which have been invented for the purpose (Figs. 99, 100, and 101). It is better, when possible, to apply the pressure to one artery, though slightly varying its position, than to change from one artery to another, as from the superficial to the common femoral, since by so doing different sets of anastomosing arteries are enlarged, and the collateral circulation may become too free.

Cases unsuitable for pressure.—1. Where the aneurysm is of very large size, or is rapidly increasing. 2. Where the sac is thin, contains but little fibrin, and appears likely soon to burst. 3. Where there is much œdema from venous obstruction. 4. Where the patient is of an irritable disposition, is intolerant of pain, or has been addicted to the abuse of alcohol. It is considered by some that even if pressure fails good may have been done by causing a deposit of fibrin in the sac, and by enlarging the collateral vessels. By others these advantages are thought to be outweighed by the irritation and disappointment to the patient of failure, and the bruising and injury of the tissues at the situation where the artery will have to be tied.

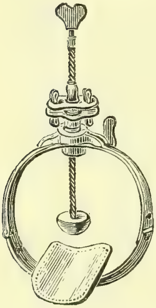


Fig. 99.—De Carte's tourniquet.

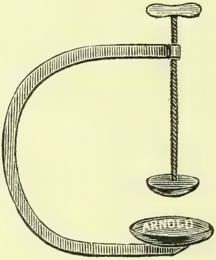


Fig. 100.—Lister's abdominal tourniquet.

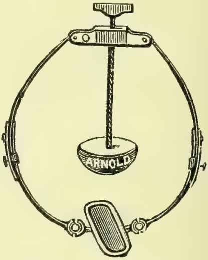


Fig. 101.—Skey's tourniquet.

(*c*) *Pressure by Esmarch's bandage* (*Reid's method*) aims at simultaneously compressing the artery above and below the aneurysm, and thus causing the blood contained in both the aneurysm and the artery to coagulate. The elastic bandage, in the case of popliteal aneurysm in which this method of compression has most often been used, should be evenly applied from the foot as far as the aneurysm; a turn should be then made over the tumour, so as only lightly, if at all, to compress the sac, and the bandaging then continued firmly half-way up the thigh. The bandage should be kept on for an hour to an hour and a half. The elastic cord should not be used at all. On removing the bandage digital pressure should be kept up on the main artery from thirty-six to forty-eight hours, so as to control the circulation and prevent the clot, while still soft, from being washed out of the artery and sac. The patient must be placed under an anæsthetic during the use of the bandage, as it causes great pain. Many cases have been cured by this method; but on the other hand there have been many failures, and it is far from being unattended with danger. Thus, gangrene of the limb and rupture of the sac have ensued, and aneurysms of internal arteries have been produced apparently by the prolonged increase of blood-pressure in the rest of the arterial system.

(*d*) *Pressure by flexion* (*Hart's method*) consists in flexing the limb so as to compress the artery by the aneurysm in imitation of that form of spontaneous cure which is brought about by the pressure of the aneurysm itself on the artery above and below. It is obviously applicable to aneurysms in but very few situations, and has been most successful in those of the popliteal artery. It may be used either alone, or in conjunction with digital or other pressure, or with medical treatment. This treatment causes much pain, and can seldom be endured.

LIGATURE, like pressure, is a very old method of treatment, but to Anel and John Hunter is due the credit of having placed it on a scientific basis. The older surgeons laid open the sac and turned out the clots, and endeavoured to staunch the hæmorrhage by ligaturing the artery above and below the aneurysm. Antyllus, it is true, applied his ligatures before opening the sac; but it was not until centuries afterwards that Anel recognized the fact that it was unnecessary to open the sac at all, and tied the artery immediately above the aneurysm. Many years later Hunter perceived that the more or less complete stoppage of the circulation obtained by Anel's method was not necessary, and that the ligature of the artery close to the sac was attended with the risk of secondary hæmorrhage and inflammation of the sac. He therefore applied his ligature at a distance from the aneurysm, where he believed moreover that the artery was likely to be in a healthier condition. For aneurysms so situated that a ligature cannot be placed on the cardiac side, Brasdor proposed tying the trunk of the artery on the distal side of the aneurysm; whilst Wardrop suggested tying one or two of the terminal branches of the artery on the distal side of the aneurysm where neither Brasdor's operation nor the proximal ligature was applicable. Hence ligature for aneurysm may be applied (Fig. 102), 1. ON THE PROXIMAL SIDE of the aneurysm either at a distance (*Hunter's method*) or immediately above it (*Anel's method*). 2. ON THE DISTAL SIDE of the aneurysm, either to the main trunk (*Brasdor's method*), or to one or more of the main branches (*Wardrop's method*). 3. IMMEDIATELY ABOVE AND BELOW the aneurysm, either opening the sac (*the old operation*), or without opening the sac (*Antyllus's method*).

1. THE PROXIMAL LIGATURE. A. HUNTER'S METHOD.—This operation, when applicable, was until recently the one almost universally adopted. The chief merits claimed for it are—1. That the artery at the spot selected for ligature is not only more likely to be healthy, but is also more easily tied than the artery in close proximity to the sac, in which latter situation, moreover, its anatomical relations are liable to be disturbed by the aneurysm. 2. That the sac is not interfered with, and hence is less likely to become inflamed and suppurate; and 3. That as several branches will probably be given off between the ligature and the aneurysm, the circulation through the sac, though lessened, will not be completely arrested, and the clot is therefore more likely to have a laminated, and hence a permanent character.

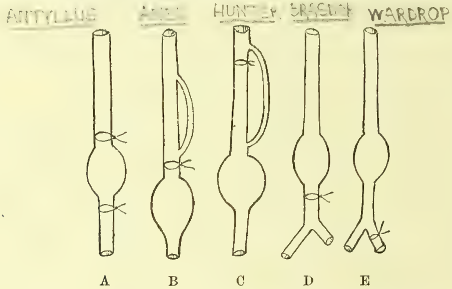


FIG. 102.—Different positions of ligature for aneurysm.

A. Antyllus's method; B. Anel's; C. Hunter's; D. Brasdor's; and E. Wardrop's.

Effects of the proximal ligature.—After the successful application of a ligature by the Hunterian method, the pulsation in the aneurysm immediately ceases, and for a time the circulation through the limb is diminished. Hence the temperature becomes lower and the surface pale. Soon, however, the collateral circulation becomes established, and a faint pulsation may be felt again in the aneurysm; but this recurrent pulsation usually grows less from day to day, and shortly ceases, and the aneurysm slowly shrinks and is finally absorbed, or remains as a small, hard, fibrous mass. The artery leading to the aneurysm may remain pervious, but it more frequently becomes obliterated as far as the first collateral branch above and below the sac. The artery on either side of the ligature also becomes obliterated as far as the first collateral branch. This condition of an aneurysm and artery after ligature is seen in the accompanying diagram (Fig. 103). The blood passes the ligature by the collateral channels; re-enters the artery below; passes the obstruction where the artery is closed at the seat of the aneurysm, also by collateral channels; and then again enters the main artery.

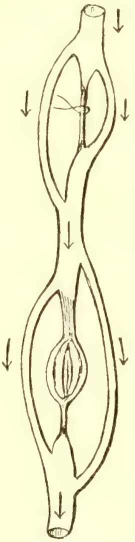


Fig. 103.—Diagram to show the condition of the artery and aneurysm after the Hunterian ligature, and the establishment of the collateral circulation. The arrows indicate the direction of the blood-current.

Treatment after ligature.—The limb should be completely swathed in the cotton-wool and flannel bandages (which, before the operation, should have already been carried up as far as the seat of the ligature), and kept at perfect rest. In the case of popliteal aneurysm, the limb should be slightly raised on a pillow, and placed on its outer side, with the knee a little flexed, care being taken that no pressure is made on the heel, malleoli, or other points of bone, for fear of local sloughing. If the weather is at all cold, hot bottles should be applied, near, but not in contact with, the limb. The patient must be kept in bed till the aneurysm is thoroughly consolidated, and the operation wound has healed.

THE DANGERS OF LIGATURE.—These are—(*a*) secondary hæmorrhage; (*b*) gangrene; (*c*) recurrent pulsation; (*d*) suppuration and sloughing of the sac; (*e*) phlebitis; (*f*) great enlargement of the aneurysm without pulsation; and (*g*) the other dangers that may attend any open wound.

(*a*) *Secondary hæmorrhage* is liable to occur at any period before the wound is soundly healed. The causes, symptoms, and treatment are discussed under "Hæmorrhage" (see p. 120).

(*b*) *Gangrene* is more common in the leg than in the arm; indeed, in the latter situation it is very rare. It may be due to—1, failure of establishment of the collateral circulation, when it usually supervenes within a few days; or 2, venous obstruction, the result of plugging of the vein in consequence either of injury at the time of operation, or of pressure on the vein by a swollen and suppurating sac. When due to the latter conditions, it may be delayed for some weeks. When extensive and spreading rapidly, amputation at the seat of ligature must be performed. The surgeon, however, should not be in too much haste to amputate, as the gangrene may involve only a toe or two, or part of the foot, and spread no further. When, therefore, it is limited in extent, and spreading slowly, a line of demarcation should be waited for before amputation is performed. When the sac is very large, and the gangrene appears to be due to pressure on the vein, the sac may at times be opened with advantage, the clots turned out, and any bleeding vessels secured, or the whole aneurysm may be excised.

(*c*) *Recurrent pulsation*, when slight, is a good sign, as it shows that the collateral circulation is becoming established, and consequently, that the danger of gangrene is lessened, if not passed. If, however, instead of ceasing, as it usually does in a few days, it becomes more pronounced, the limb should be raised, and carefully bandaged from the foot upwards, and pressure applied to the artery leading to the sac. If this does not suffice, and the pulsation returns as strongly as ever, and the aneurysm again begins to increase in size, it is clear that the ligature has failed, and it becomes a grave question what further treatment should be undertaken. Should it appear that a large branch is feeding the aneurysm, this should undoubtedly be secured; otherwise the choice will probably lie between—1, pressure upon the artery and aneurysm; 2, the use of Esmarch's bandage; 3, flexion in the case of a popliteal aneurysm; or, if these fail, 4, tying the vessel either just above the aneurysm or above the former ligature; 5, cutting down upon the sac, and securing both ends of the artery; 6, excision; or, 7, amputation. Much will turn on each individual case, but the discussion as to a choice of method is too long to be entered upon here. As a rule, I should myself excise the aneurysm.

(*d*) *Inflammation and suppuration of the sac* may be met with after pressure, as well as after ligature; and although it may occur after the Hunterian operation, is more frequent in cases where the ligature has been applied close to the sac, or where rapid pressure has been used. It appears to be due to—1, the spread of inflammation to the sac from the wound, which has become septic; 2, the formation in the sac of a soft coagulum; or 3, excessive manipulation before the operation. It is ushered in with redness, heat, pain, and swelling of the sac (which has not undergone the usual process of shrinking), and œdema of the surrounding parts. Later the skin gives way, and a mixture of pus and broken-down coagula escapes. It may be accompanied by hæmorrhage; but more commonly the vessel has become sealed, and no bleeding occurs. The abscess should be opened as soon as pus has formed, a grooved needle being previously inserted if there is doubt on this point. Should hæmorrhage occur, the clots must be turned out, and the artery secured above and below, or the sac may be excised, or amputation performed.

(*e*) *Phlebitis* may occur from injury to the vein in passing the aneurysm needle. Should the vein be pricked, an accident which may be known by venous blood welling up by the side of the ligature, the artery should on no account be tied at this spot, as the ligature, should the wound become septic, would act as a seton in the vein, and death possibly ensue from phlebitis or pyæmia. The ligature, if already passed, should be withdrawn, pressure applied to the vein, and the artery tied higher up. Where this treatment has been adopted, I have never seen any ill results follow the injury.

B. ANEL'S OPERATION was seldom done until recent years, except where the Hunterian method was inapplicable, as for aneurysm in the groin, aneurysm of the upper part of the common carotid, &c. The disadvantages said to attend it are—1, that the artery is likely to be diseased, and hence there is greater risk of secondary hæmorrhage; 2, that its anatomical relations are apt to be disturbed by the contiguity of the sac; 3, that the sac itself is liable to be injured during the operation, and to become inflamed and suppurate; and 4, that the clot which forms in the sac is of the soft or passive variety in consequence of there being no circulation in the sac. Of late years this method has been revived at St. Bartholomew's for the treatment of popliteal aneurysm, and the popliteal artery is there now frequently tied. It has been found to diminish the risk of gangrene, and holds out a greater certainty of cure. Gangrene is less likely to occur when only the popliteal is obstructed close to the aneurysm than when both the popliteal and femoral are blocked. Recurrent pulsation and failure after ligature of the femoral are due to too free a supply of blood flowing into the artery below the ligature (Figs. 103, 107); when the popliteal is tied this is prevented. Moreover the popliteal has been found quite as healthy as the femoral; it is easily tied at its upper part without disturbing the sac; and there appear to be sufficient small vessels given off from the artery between the ligature and the aneurysm to ensure by their anastomosis with other small vessels given off above the ligature some circulation in the sac and the formation of an active clot.

2. THE DISTAL LIGATURE should only be used where the Hunterian or Anel's method cannot be applied. *Brasdor's method*, which consists in securing the main trunk on the distal side of the aneurysm, may be employed in aneurysm of the carotid at the root of the neck. It copies that method of spontaneous cure in which a clot blocks the artery beyond the aneurysm. After the ligature the clot that forms in the artery may extend to the aneurysm, which thus becomes filled by a coagulum; or the

blood-pressure in the sac may become so diminished that laminated fibrin is deposited. Unfortunately, however, in practice the blood pressure in the aneurysm appears in some cases to be increased rather than diminished. *Wardrop's method* consists in securing two or more of the main branches of the artery on the distal side of the aneurysm. It aims at cutting off part of the blood-stream through the aneurysm, and so, by reducing the blood-pressure, promoting the deposition of laminated coagulum. It has been applied to the subclavian and carotid arteries for aneurysm of the innominate ; but the success attending it has not been great. The chief risks are passive enlargement and subsequent bursting of the sac, or inflammation and suppuration of the sac.

3. THE DOUBLE LIGATURE.—Ligature above and below the sac, either, 1, by the old method of first laying the sac open and then securing the bleeding ends of the artery ; or, 2, by the method of Antyllus, of first securing the artery and then laying the sac open, is only employed in exceptional cases. Thus the *old method* is sometimes resorted to in traumatic aneurysm of the axillary artery in preference to tying the subclavian, and also in gluteal aneurysm where the Hunterian method of tying the common or internal iliac is attended with so much risk. The great danger is the patient dying under the operation of hæmorrhage. During the operation, therefore, in the case of the axillary artery, pressure should be made on the subclavian, an incision through the skin and fascia above the clavicle being made to ensure its better control. In the case of the gluteal, Davy's lever or the abdominal tourniquet should be used. The true *method of Antyllus* may, in rare instances, be required, as in some forms of aneurysm at the bend of the elbow.

MANIPULATION.—A spontaneous cure, as we have seen (p. 270), is sometimes brought about by the impaction of a portion of clot either in the mouth of the sac or in the artery below. Manipulation of the sac aims at breaking up and displacing such clot as may have formed in the hope that a portion may become impacted in this way, and so lead to consolidation. Sir William Fergusson, who first introduced this method, used it with success, and others have done so likewise. It is far from being unattended with danger, however, since a portion of the clot may be carried away by the blood-stream and become lodged in a vessel leading to an important organ, as the brain. It should, therefore, only be tried when other means are impracticable or appear attended with even greater risk.

IRRITATION OF THE INTERIOR OF THE SAC BY NEEDLES (MACEWEN'S METHOD).—This method aims at so irritating the walls of the aneurysm as to induce slight inflammation and the formation of white thrombus. The skin having been made aseptic, long needles are passed into the sac and the walls systematically scratched all round the aneurysm. It is applicable to aneurysms where pressure or proximal ligature cannot be employed. Consolidation occurs very slowly. Our experience of this method is at present very limited. In a case of aneurysm at the root of the neck in which I tried it the results were such as to lead me to think it has a future.

Excision of the whole aneurysm.—Of late years several successful cases of the complete excision of spontaneous aneurysm have been recorded. I thus removed a large carotid aneurysm at St. Bartholomew's during last year. The sac should be exposed, the artery sought on the proximal side, tied in two places and divided. The sac should be next carefully dissected out, the artery on the distal side tied, and the whole aneurysm removed. The advantages of total extirpation are—1, the aneurysm is completely cured, whereas after other methods recurrence may take place even after months or years; 2, the danger of soft clot being washed out of the sac into the circulation is avoided; 3, all vessels that are likely to give rise to secondary hæmorrhage can be ligatured; 4, the cicatricial contraction of the sac and consequent risk of the involvement of nerve trunks is averted. The disadvantages of the operation are—1, the difficulty of its execution; 2, the danger of wounding important parts to which the sac has formed adhesions, as the attendant vein or nerve trunks; and 3, the long and tedious dissection that may be required. The argument that the artery near the sac is unhealthy has no weight, since it has been shown of late that atheroma is not oftener found there than at a distance, and atheromatous arteries can be occluded by sterile ligatures without fear of secondary hæmorrhage. Total extirpation should certainly be chosen before amputation, except when precluded by the position of the aneurysm or by the patient's age or feeble condition.

Galvano-puncture, electrolysis, injections of perchloride of iron, tannin, and the like, and the introduction of foreign bodies as horsehair or iron wire, which have all for their object the coagulation of the blood in the sac, are highly dangerous procedures, and have not hitherto been attended with much success.

SPECIAL ANEURYSMS.

Internal aneurysms, falling as they do under the care of the physician rather than of the surgeon, will be referred to only in as far as an aneurysm of the arch of the aorta, of the innominate, of the first portion of the subclavian, and of the portion of the left common carotid within the chest may present as a pulsating tumour at the root of the neck, and as such may call for surgical treatment.

Aneurysm at the root of the neck.—The differential diagnosis of aneurysm in this situation is always difficult, at times impossible. Indeed the aneurysm may involve more than one artery, perhaps all three of the main branches of the aortic arch, and even the arch itself as well. The sign common to all forms, whatever the artery implicated, is a pulsating tumour at the root of the neck, in which a loud bruit can generally be heard. When the aneurysm involves the *aorta*, it generally presents just above the suprasternal notch, and there are symptoms within the chest of the aorta being affected. When the *innominate* is implicated, the aneurysm projects between the two heads of origin of the sterno-mastoid muscle; and the pulse in the temporal and radial arteries is smaller on the right than on the left side, and is aneurysmal in character (see p. 271). When the aneurysm involves the *common carotid*, it presents beneath the inner head of the sterno-mastoid, and tends to extend upwards in the neck by the side of the trachea; the bruit is transmitted up the carotid, and the pulse in the temporal is smaller on the affected than on the sound side, and is aneurysmal; but the pulse in the radial is the same on both sides. When the *subclavian* is involved, the tumour is external to the sterno-mastoid; it extends in the direction of the subclavian artery, the bruit is transmitted towards the axilla, and the pulse at the wrist is diminished in volume and is aneurysmal. Such is a brief outline of the differential diagnosis of these aneurysms; but there are many other signs due to the pressure of the aneurysm on the veins, nerves, œsophagus, trachea, &c., which have to be taken into consideration, and for an account of which a work on Medicine must be consulted. *Treatment.*—When the aneurysm is *aortic*, medical means, combined in some cases with Macewen's method of scratching the interior of the sac with needles, may be employed. When the *innominate* is involved, Macewen's method should certainly first be tried. This failing, medical means and pressure on the carotid, or distal ligature of the carotid and subclavian arteries simultaneously may be employed. If these do not prove successful or are impracticable owing to the large size of the aneurysm, nothing is left but the desperate resort to galvano-puncture, electrolysis, or the introduction of iron wire. When the *carotid* or *subclavian* is affected, Macewen's method and medical means may also in the first instance have due trial; afterwards, in the case of the *carotid*, distal compression or ligature may be tried, and, in the case of the *subclavian*, distal compression or ligature if practicable, ligature of the innominate, direct pressure on the sac, or the terrible expedients of amputation at the shoulder-joint, manipulation, galvano-puncture, injection of coagulants, or the introduction of iron wire. The innominate artery has now been tied for this condition three times with success.

Carotid aneurysm.—Aneurysm of the carotid at the root of the neck has been alluded to above. Aneurysm of the common trunk higher in the neck presents the ordinary signs of aneurysm, and in this situation has to be diagnosed from—1, simple dilatation of the artery at its bifurcation; 2, enlarged glands; 3, abscess or tumour over the artery; 4, pulsating goître. In simple dilatation there is no bruit; in enlarged glands and tumours there is also no bruit, and the pulsation is not expansile, and ceases when they are lifted up from the vessel; in abscess, in addition to the absence of the above signs, there is the history or presence of inflammation; in pulsating goître the tumour moves up and down with the larynx on deglutition. The usual *treatment* consists in pressure or ligature of the artery below the aneurysm, or if there is not room in this situation, distal ligature. In a case recently under my care I dissected out a large carotid aneurysm, the patient making an uninterrupted recovery. I can speak most favourably of this method of treatment.

Aneurysm of the external and internal carotids requires no special mention. Pressure or ligature of the common carotid is the treatment generally indicated.

Orbital aneurysm.—Several conditions may give rise to the group of symptoms to which the name "orbital aneurysm" has been applied. In only one instance has the existence of a circumscribed aneurysm in the orbit been verified by an autopsy. In the other cases that have proved fatal the following conditions were found:—1. Thrombosis of the cavernous sinus. 2. Communication between the carotid artery and cavernous sinus. 3. Dilatation of the carotid artery. 4. Aneurysm of the ophthalmic artery *within* the cranium. The *general symptoms* are:—Pulsation over the whole or part of the orbit; protrusion of the eyeball with loss or impairment of sight; more or less pain; and a loud bruit which can also often be heard by the patient himself. The differential diagnosis of the several conditions producing these symptoms is one of great difficulty and cannot be entered upon here. *Treatment.*—The symptoms have been known to subside spontaneously. Where they have not done so ligature of the carotid has been attended with the best results. Injection of perchloride of iron has been recommended, but I should hesitate to use it myself for fear of venous thrombosis and embolism. Where the pulsation has followed a punctured wound of the orbit it has been advised to extirpate the globe and secure the bleeding vessel in the orbit. In a case of the kind under the care of my colleague, Mr. Power, ligature of the common carotid was attended with perfect success.

Axillary aneurysm is not uncommon as the result of sprains, or of attempts to reduce long-standing dislocations of the shoulder. The *diagnosis*, as a rule, presents no difficulty except the aneurysm has become diffused, when it may be mistaken for abscess. *Treatment.*—1. When the aneurysm is spontaneous, small, and well circumscribed, pressure or ligature of the third part of the subclavian should be practised. 2. When more or less diffused, as when the result of an injury to the artery in the reduction of a dislocation, the aneurysm should be cut down upon, the clots turned out, and the vessel secured above and below. If this operation is decided on, an incision should be made over the subclavian artery through the skin and fascia, so that pressure may be made on it more directly, and the circulation through the aneurysm during the subsequent operation better controlled. A small incision is then made over the aneurysm, two fingers are introduced into it, and placed on the bleeding spot in the artery, which may be known by the hot arterial blood issuing from it. An assistant in the meantime enlarges the wound, turns out the clots, and helps the surgeon to tie the artery above and below the rupture before the fingers are removed. This method is less dangerous than that practised by Syme, who made a free incision over the aneurysm, rapidly turned out the clots, and seized with forceps the bleeding point in the artery. If the artery on the proximal side of the aneurysm can be reached it should be tied before the tissues forming the sac are incised, but seeing that it is a ruptured artery that is being dealt with, this would seldom be practicable. 3. Where the aneurysm is of great size and involves the subclavian, Macewen's method may be employed or the first part of the subclavian or the innominate may be ligatured, or iron wire introduced, galvano-puncture or manipulation tried, or amputation at the shoulder-joint performed. Space does not permit of a discussion of the cases in which one or other of these methods is the more suitable. All, however, with the exception of Macewen's method, are desperate expedients.

Aneurysms at the bend of the elbow were formerly common when venesection was in vogue, and were then generally arterio-venous in character (see p. 193).

Gluteal aneurysm is the term applied to aneurysm of the gluteal artery itself, the sciatic, or the pudic where it winds over the spine of the ischium. Aneurysms in this situation may be the result of a wound or other injury, or may occur spontaneously. They are frequently attended with pain and interference with the movements of the hip-joint. The pulsation and bruit will generally serve to distinguish them, but there may be no pulsation, as where the aneurysm has burst, or blood has been effused into the tissues as the result of a wound of the artery; a tumour of bone, moreover, may also pulsate. Under such circumstances, exploration with a grooved needle will be necessary. *Treatment.*—When of traumatic origin, an incision should be made over the tumour, the clots turned out, and the bleeding vessel secured, the hæmorrhage during the operation being controlled by pressure on the common iliac by Davy's lever or by the hand in the rectum. When spontaneous, the internal iliac may have to be tied if the aneurysm encroaches on that vessel within the pelvis—a point which may perhaps be determined by exploring with the hand in the rectum. Before, however, resorting to ligature of the internal iliac, Macewen's method or compression of the abdominal aorta or common iliac, and carefully applied direct pressure on the swelling should be tried. Galvano-puncture and the introduction of coagulants have been employed successfully in this aneurysm.

INGUINAL ANEURYSMS are those which involve either the termination of the external iliac, or the commencement of the femoral. They may extend either upwards along the course of the iliac into the abdomen, or downwards in the course of the femoral into the thigh. They may have to be diagnosed from enlarged inguinal glands over the artery, tumours, especially pulsating tumours of the pelvic bones, and abscesses. From abscess and tumour they may be distinguished by the signs already several times alluded to. Their diagnosis from pulsating tumours of bone is often very difficult, and the external iliac has before now been tied by the most able surgeons under the impression that such a tumour was an aneurysm. The diagnostic points have already been given under *Pulsatile Tumours of Bone* and *Diagnosis of Aneurysm* (pp. 228, 272). *Treatment.*—1. When the aneurysm is of moderate dimensions, and involves only a small portion of the external iliac, this vessel should be tied, or if preferred, an attempt may first be made to compress it. 2. Where there is apparently not room to apply a ligature to the vessel, rapid compression of the abdominal aorta may be employed, combined in some cases with distal pressure. 3. Where there is not room for the tourniquet on the aorta, medical means must be relied on, or Macewen's method tried. This failing the common iliac may be tied; or the desperate experiment made of tying the aorta, or injecting coagulants, or passing iron wire into the sac. On the whole, if pressure or Macewen's method fail, ligature of the common iliac by the intraperitoneal method or the excision of the aneurysm perhaps holds out the best chance of success.

FEMORAL ANEURYSM requires no special remark other than that when situated in Hunter's canal, the femoral should be compressed or tied in Scarpa's triangle. When situated in Scarpa's triangle, he external iliac may be treated in the same way. In either ituation Esmarch's bandage may be used if this method of treatment commends itself to the surgeon's judgment.

POPLITEAL ANEURYSM.—The frequency of aneurysm in this ituation is attributed to—1, the bifurcation of the popliteal artery nto the anterior and posterior tibial whereby the circulation through it may be slightly obstructed, or an embolus be readily impacted; 2, the artery being unsupported by muscles, and in contact with the bone; 3, the strain on the artery in the movements of the knee-joint; 4, the compression that may be exerted on the end of the artery by the strong fibrous arch of origin of the soleus muscle. A popliteal aneurysm is not usually difficult to diagnose, but should it become diffused, suppurate, or break into the knee-joint, it may be mistaken for a malignant tumour of the bones, an abscess, or an affection of the joint. The history of the case, the consideration of the diagnostic signs of aneurysm already given, and the introduction of an exploring needle into the knee when blood has been effused into the joint, will usually clear up any doubt as to the nature of the affection. A popliteal aneurysm is often bilateral. *Treatment.*—Little need be added here to what has already been said on the general treatment of aneurysm, as such especially applies to aneurysm in this situation. Flexion, combined with appropriate medical treatment, is often successful; and digital and instrumental compression are especially applicable to this aneurysm, or an Esmarch's bandage may be used if preferred. These methods failing or not being considered advisable, the popliteal in the upper part of its course or the femoral artery in Scarpa's triangle should be tied. The operation of tying should be done at once under the following circumstances:—1. When the aneurysm is rapidly increasing in size, leaking, or threatening to burst. 2. When the aneurysm is inflamed but has not suppurated. 3. Under some circumstances when it has burst into the knee-joint. 4. When the limb is œdematous, showing that the vein is being seriously compressed. 5. When the patient is of an irritable disposition, addicted to alcohol, and impatient of control. Amputation, on the other hand, is, as a rule, called for:—1. If the aneurysm has burst. 2. If gangrene has set in. 3. If suppuration attended with profuse hæmorrhage has occurred; and 4. If the knee-joint is disorganized.

LIGATURE OF ARTERIES.

The *ligature of arteries* requires a knowledge of their relational anatomy and of the position and appearance of the various structures which serve as guides to them. Such a knowledge can only be gained in the dissecting-room, and by the frequent practice of operations on the dead body. Here only the chief rules that should guide us in applying a ligature, and a short account of the methods of tying the more important arteries, can be given.

General rules for ligature:—1. The incision should generally be made parallel to the course of the artery, and the skin divided evenly to promote union by first intention. 2. Each successive cut through the underlying tissues should be made the same length as that through the skin, and bruising of the parts avoided as much as possible. 3. The sheaths of muscles and tendons should not, if possible, be opened. 4. The sheath of the vessel having been exposed and the artery felt pulsating with the index finger, the sheath should be pinched up with forceps and opened by cutting with the blade of the knife on the flat. 5. The sheath being opened, it must be separated from the artery in the whole of its circumference, either by careful dissection with the knife turned with its edge from the artery, or by the director insinuated by a gentle to and fro movement between the sheath and the artery. If this part of the operation is not done very delicately, too much of the sheath in the long axis of the artery will be separated, and there will be danger of secondary hæmorrhage from cutting off of the blood supply which the vessel receives from its sheath. 6. Having separated the sheath, one side of it should be seized with the forceps and the needle passed, unthreaded, between it and the artery, and the point, by a gentle to and fro movement, carried round the vessel without injuring or including any of the contiguous structures. It should, save in exceptional cases which will be mentioned, be passed from the side on which the vein lies. 7. When the point of the needle projects on the opposite side, it should be cleared from any loose cellular tissue of the sheath it may have carried before it by scratching with the finger-nail, or cutting on the needle with the edge of the scalpel directed from the artery. 8. The artery should be gently pressed between the curve of the needle and the finger to ascertain that no other structure is included, and that pressure controls the pulsation in the aneurysm. 9. The needle should now be threaded with the ligature which is carried round the artery as the needle is withdrawn; the ligature should then be tied in a reef knot and its ends cut off short. 10. Should much of the sheath have been unavoidably separated from the artery, two ligatures had better be passed, and the artery divided between them. I question if this will not always be found the safer method: it is now the one always used by myself and by several of my colleagues at St. Bartholomew's. 11. Some form of aseptic ligature should be used, as silk, chromicized catgut, ox-aorta, or kangaroo-tail tendon, but the best material can hardly be said to have been determined. I have always used kangaroo-tail tendon myself, and have found it answer admirably. 12. The wound should be accurately united, drained if deep, and dressed antiseptically.

LIGATURE OF SPECIAL ARTERIES.

THE INNOMINATE ARTERY has now been tied twenty-nine times, and five times successfully. Its ligation may be required for—1, subclavian, and 2, carotid aneurysms, at the root of the neck.

It has also been tied for, 3, hæmorrhage from the subclavian and axillary artery. In exposing the vessel the sterno-mastoid, sterno-hyoid and sterno-thyroid have to be divided, or the sternal end of the clavicle and part of the manubrium sterni may with advantage be removed. In a recent case Burrell, by drawing on the carotid, brought the innominate better within reach below the subclavian aneurysm. Care must be taken not to injure the internal jugular and innominate vein, the vagus and phrenic nerves and the pleura.

THE COMMON CAROTID ARTERY may require tying for—1. Wound of the artery; 2, a punctured wound near the angle of the jaw or tonsil; 3, aneurysm of the upper part of the artery or of one of its branches; 4, orbital, intracranial and cirsoid aneurysm; and 5, aneurysm at the root of the neck (distal ligature). The artery may be tied either above or below the omo-hyoid. When practicable it should be tied above, as it is here more superficial, and the risk of suppuration extending beneath the deep fascia into the chest is avoided. *The high operation, or ligature above the omo-hyoid.* Make an incision three inches in length with its centre opposite the cricoid cartilage, along the anterior edge of the sterno-mastoid muscle, *i.e.*, in a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process (Fig. 294, i). Divide the skin, superficial fascia, platysma and deep fascia. Draw the anterior edge of the sterno-mastoid gently outwards, and the artery will be felt pulsating in the angle formed by the omo-hyoid with the sterno-mastoid. Open the sheath on its inner side, and pass the aneurysm needle from without inwards to avoid injuring the vein which slightly overlaps the artery on its outer side, and keep its point close to the vessel lest the pneumogastric nerve be included in the ligature. The small descendens cervicis nerve runs superficial to the sheath, and if seen, should be avoided. The superior thyroid, lingual and facial veins cross the artery to open into the internal jugular vein. Should they impede the operation, divide them, having first applied two ligatures. *The low operation, or ligature above the omo-hyoid.* Make an incision in the same line as for the high operation but lower in the neck. Draw the sterno-mastoid outwards and the sterno-hyoid and thyroid inwards and the artery will be felt beating in the angle formed by the omo-hyoid with the sterno-thyroid. Pass the needle as before from without inwards, taking especial care not to injure the vein which on the left side slightly overlaps the artery. The head should be kept fixed after ligature by sand bags or some form of splint. The *chief dangers* after ligature are—1. Cerebral mischief from partial cutting off of the blood supply to the brain; 2, a low form of pneumonia from interference with the blood supply of the respiratory centre; 3, suppuration descending into the mediastinum; and 4, suppuration of the sac when tied for aneurysm. The *collateral* *circulation* (Fig. 104) is carried on by the anastomosis of—1. The vertebral with the opposite vertebral. 2. The inferior with the superior thyroid. 3. The internal carotid with the opposite internal carotid through the circle of Willis. 4. The deep cervical, ascending

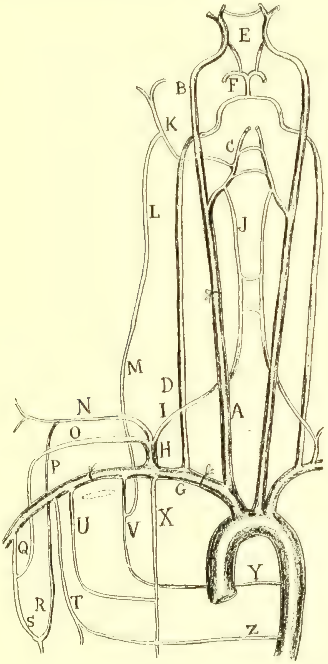


Fig. 104.—Diagram to show the collateral circulation after ligature of common carotid, subclavian and axillary arteries. A. Common carotid; B. Internal carotid; C. External carotid; D. Vertebral; E. Circle of Willis; F. Basilar; G. Subclavian; H. Thyroid axis; I. Inferior thyroid; J. Superior thyroid; K. Occipital; L. Princeps cervicis; M. Deep cervical; N. Transversalis colli; O. Supra-scapular; P. Posterior scapular; Q. Dorsalis scapulæ; R. Infra-scapular; S. Subscapular; T. Long thoracic; U. Short thoracic; V. Superior intercostal; X. Internal mammary; Y. and Z. Aortic intercostals.

ervical, and superficial cervical, with the princeps cervicis of the ccipital. 5. Branches of the external carotid with the corre-ponding branches of the opposite side across the middle line of the eck.

The external and internal carotid arteries may be tied y an incision similar to that for the common carotid, but higher in the neck. A point to remember is that the internal carotid is in position at first external to the external carotid and of larger size.

THE LINGUAL ARTERY may require ligature for hæmorrhage in cancer of the tongue, and as a preliminary to excision of the tongue. Make an incision along the greater cornu of the hyoid bone (Fig. 294, g); divide the skin, superficial fascia and platysma; hook up the submaxillary gland, and a few touches of the director will expose the triangle bounded below by the anterior and posterior belly of the digastricus and above by the hypoglossal nerve. Scratch cautiously through the muscular fibres of the hyo-glossus which forms the floor of this triangle, taking care not to injure the lingual vein which is superficial to the muscle; the lingual artery will be seen or felt lying upon the middle constrictor of the pharynx. The vessel, however, is often abnormal, and consequently may not be found in the usual situation.

THE FACIAL ARTERY is readily tied at the anterior edge of the masseter, where it can be felt beating. It lies anterior to its vein. It has frequently to be tied in its course through the neck in the removal of glands from that region.

THE SUPERIOR THYROID ARTERY can seldom require tying except for wounds of the neck, as "cut throat," and as a preliminary to removal of the thyroid body.

THE TEMPORAL ARTERY may require ligature for cirsoid aneurysm or a wound of the vessel. It can be readily secured at the spot where it is felt beating as it crosses the zygoma just in front of the external auditory meatus (Fig. 294, h).

THE SUBCLAVIAN ARTERY may be tied in the *third part of its course* for—1, axillary aneurysm; 2, aneurysm at the root of the neck (distal ligature); 3, ruptured axillary artery; 4, secondary hæmorrhage after amputation at the shoulder-joint; and 5, as a preliminary to the latter operation. The head having been drawn well back, the face turned to the opposite side and the shoulder depressed, draw down the skin over the clavicle, make an incision along the middle third of that bone through the integuments and platysma, so as to avoid injuring the external jugular vein, and let the tissues slip up again (Fig. 294, f). Next divide the deep fascia on a director, and the posterior edge of the sterno-mastoid will be exposed. Hold aside or divide if necessary the external jugular or any other vein that may be in the way, but do not injure the supra-scapular artery, as this is one of the chief vessels by which the collateral circulation will subsequently be carried on. Search with the finger and director for the scalene tubercle in the triangle bounded by the omo-hyoid above, the clavicle below, and the scalenus anticus on the inner side: the artery will be felt pulsating behind the tubercle. It has the vein in front of it, but on a lower plane, and the brachial plexus above it. Pass the needle from above downwards. The artery, if necessary, may be tied in *the second part of its course* by extending the incision inwards and partially dividing the scalenus anticus. Ligature of *the first part* has been so uniformly fatal hitherto that it will not be described. The *principal accidents* that may occur during ligature of the subclavian in the third part of its course are—1, injury of the external jugular vein or other veins, and profuse venous hæmorrhage; 2, wound of the sac of the aneurysm; 3, puncture of the pleura; 4, inclusion of a cord of the brachial plexus; 5, injury of the phrenic nerve. The *chief dangers after ligature* are pleurisy, secondary hæmorrhage, and suppuration of the sac. The *collateral circulation* (Fig. 104) after ligature of the third portion is carried on by—1, the supra-scapular and posterior scapular arteries anastomosing with the infra-scapular, subscapular, and dorsalis scapulæ arteries; 2, the internal mammary, superior intercostal and aortic intercostal arteries anastomosing with the long and short thoracic arteries.

THE AXILLARY ARTERY can seldom require ligature except for wound or rupture (p. 189). In its continuity it may be tied in the first, second, and third part of its course. In *the third part* it can be readily secured by making an incision, with the arm raised, through the skin and fascia along the inner border of the coracobrachialis and biceps (Fig. 106, b). In *the first and second parts* of its course it lies below the pectoral muscles, and to expose it so deep a dissection is required, that ligature of the subclavian is preferable. The *collateral circulation* (Figs. 104 and 105) after ligature of the first portion of the axillary is carried on by the same vessels as after ligature of the third part of the subclavian. After ligature of the third part of the axillary it is carried on chiefly by the anastomosis of small branches of the subscapular and circumflex above with similar branches of the superior profunda below.

THE BRACHIAL ARTERY may require ligature for—1, wound of the artery; 2, aneurysm at the bend of the elbow; 3, wound of the palmar arch. It may be tied in any part of its course. Make an incision (Fig. 106, c), along the inner edge of the biceps in a line drawn from the anterior fold of the axilla to the middle of the bend of the elbow through the integuments and deep fascia, avoiding the basilic vein which lies over the course of the artery but superficial to the fascia. The median nerve crosses the artery along the middle of its course from without inwards. At the *bend of the elbow* make the incision obliquely from within outwards (Fig. 106, d) and divide the semilunar fascia of the biceps: the artery will be found between the tendon of the biceps on the outer side and the median nerve on the inner side. The *collateral circulation* (Fig. 105) when the artery is tied above the superior profunda is the same as that after ligature of the third part of the axillary.

When tied below the superior profunda it is carried on chiefly by the anastomosis of this vessel with the radial and interosseous recurrent and the anastomotica magna; when tied below the inferior profunda by the additional anastomosis of this vessel with the posterior ulnar recurrent.

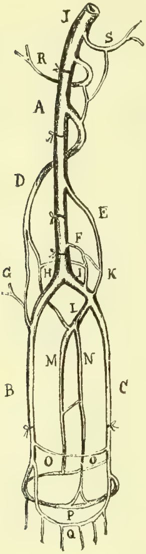


Fig. 105.—Diagram to show the collateral circulation after ligature of the axillary brachial and radial and ulnar arteries. A. Brachial; B. Radial; C. Ulnar; D. Superior profunda; E. Inferior profunda; F. Anastomotica magna; G. Radial recurrent; H. Interosseous recurrent; I. Anterior and K. posterior ulnar recurrent; J. Axillary; L. Common interosseous; M. Posterior interosseous; N. Anterior interosseous; O O. Anterior and posterior carpal; P. Deep palmar arch; Q. Superficial palmar arch; R. Posterior circumflex; S. Subscapular.

The radial and ulnar arteries may be tied for—1, aneurysm of either vessel, or, 2, wound of the palmar arch; but it is a question whether ligature of the brachial is not preferable in the latter case, as the anastomosis between the radial and ulnar and the carpal and interosseous arteries is so free (Fig. 105). Both arteries in the case of a wound of the palmar arch need to be tied. This is best done *at the wrist* where they are superficial and can be felt pulsating. The radial lies between the supinator longus and the flexor carpi radialis; the ulnar between the innermost tendon of the flexor sublimis digitorum and the flexor carpi ulnaris, by which latter tendon it is slightly overlapped. An incision about an inch long through the integuments and deep fascia parallel to the course of either vessel, is all that is necessary to expose them (Fig. 106, g, h). In the case of the ulnar, however, the flexor carpi ulnaris may have to be held aside. The aneurysm needle should be passed from the ulnar to the radial side to avoid the nerve which lies to the ulnar side. In the case of the radial, the needle may be passed either way as the radial nerve at the wrist is not in contact with the artery. No harm will ensue if the venæ comites are tied with their respective vessels. *The radial artery in the upper third* lies deeply between the supinator longus and pronator radii teres. Make an incision (Fig. 106, e) in a line drawn from the middle of the bend of the elbow to half an inch internal to the styloid process of the radius. Separate the muscles and the artery will be exposed. The radial nerve in this situation is some distance to the outer side of the artery. *Ligature of the ulnar in the upper third* is more difficult as it lies beneath the superficial flexor muscles. Make an incision (Fig. 106, f) four inches long in a line drawn from the front of the internal condyle to the radial side of the pisiform bone. Seek the interval between the flexor carpi ulnaris and the flexor sublimis digitorum. Separate these muscles, and the ulnar nerve will be seen. Work superficial to the nerve, and the artery will be found between the flexor sublimis and flexor profundus digitorum. For *collateral circulation* after ligature of the radial and ulnar arteries, see Fig. 105.

THE EXTERNAL ILIAC ARTERY may require ligature for—1, Aneurysm in the groin; 2, secondary hæmorrhage from the femoral; 3, a wound of the vessel itself. A line drawn from half an inch below and a little to the left of the umbilicus to the middle of Poupart's ligament indicates its course. Make a curved incision beginning a little external to the centre of Poupart's ligament upwards and outwards for about three inches towards the anterior superior spine of the ilium (Fig. 305, c). Divide the skin, superficial and deep fascia, and the aponeurosis of the external oblique; cut more carefully through the internal oblique and transversalis muscles, and the fascia transversalis will be exposed. Divide this on a director, taking care not to injure the peritoneum. Separate the peritoneum gently from the psoas muscle, and let an assistant press it carefully upwards and inwards. The artery will now be felt beating at the inner part of the wound along the inner border of the psoas. Pass the aneurysm needle from within outwards to avoid injuring the vein which lies to the inner side of the artery. The small crural branch of the genito-crural nerve lies on the artery, and the circumflex iliac vein and vas deferens cross it just before it passes under Poupart's ligament. The *chief accidents* that may occur during ligature are:—1, Injury of the peritoneum; 2, wound of the vein; 3, wound of the spermatic cord; 4, wound of the epigastric artery; and 5, puncture of the circumflex iliac vein,

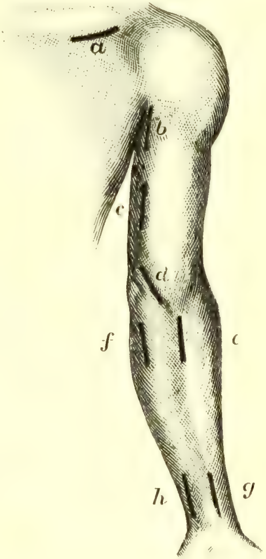


FIG. 106.—Lines of incision for ligature of arteries of the upper extremity.

The *chief dangers* after ligature are:—1, Gangrene of the limb; 2, peritonitis; 3, secondary hæmorrhage. Should secondary hæmorrhage occur, carefully applied pressure must be tried. If this fails, nothing is left but the desperate expedient of cutting down on the bleeding vessel and trying to secure it. Davy's lever should be used to control the hæmorrhage during the operation. The peritoneum will be probably opened, and success will be problematical. The *collateral circulation* (Fig. 107) is carried on chiefly by the anastomosis between the internal mammary and deep epigastric; the ilio-lumbar and circumflex iliac; the gluteal and external circumflex; the obturator and internal circumflex; the sciatic and the superior perforating and internal circumflex.

THE COMMON ILIAC ARTERY has been ligatured for aneurysm of the external iliac and for gluteal aneurysm; the INTERNAL ILIAC ARTERY also for gluteal aneurysm. Both may be reached by prolonging the incision for ligature of the external iliac, and both have recently been tied through the peritoneum. Both operations were formerly attended with the most unfavourable results, but of late there have been several successful cases in which the abdomen has been opened in the middle line, the intestines drawn aside and the vessels exposed by scratching through the peritoneum. For *collateral circulation*, see Fig. 107.

THE SUPERFICIAL FEMORAL ARTERY may be ligatured for—1, Wound of

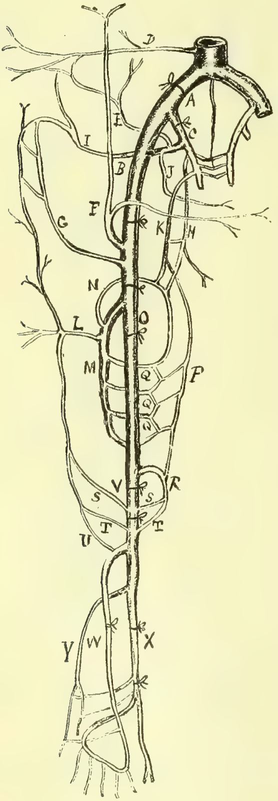


FIG. 107.—Diagram of the collateral circulation after ligature of the common iliac, external and internal iliac, femoral, popliteal, and arteries of the leg. A. Common iliac; B. External iliac; C. Internal iliac; D. Last lumbar; E. Ilio-lumbar; F. Epigastric; G. Circumflex iliac; H. Obturator; I. Gluteal; J. Lateral sacral; K. Sciatic; L. External circumflex; M. Profunda; N. Internal circumflex; O. Femoral; P. Comes ischiatici; QQQ. Perforating; R. Anastomotica magna; SS. Superior articular; TT. Inferior articular; N. Tibial recurrent; V. Popliteal; W. Anterior tibial; X. Posterior tibial; Y. Peroneal.

the artery itself; 2, popliteal aneurysm; 3, hæmorrhage from a wound of one of the tibials. The ligature may be applied either in Scarpa's triangle or in Hunter's canal. *In Scarpa's triangle* the artery is usually tied at the apex where the sartorius touches the adductor longus. If thought necessary, the line of the sartorius may be marked on the skin with lunar caustic by putting the muscle in action before the patient is anaesthetized. Slightly flex the leg, and place the thigh on its outer side in a position of slight abduction and flexion. A line drawn from a point midway between the symphysis pubis and the anterior superior iliac spine to the adductor tubercle in this position indicates the course of the artery (Fig. 108, a). Make an incision about three inches long in this line, beginning about four inches below Poupart's ligament; cut through the skin and superficial fascia, and divide the deep fascia on a director. Draw the sartorius gently *outwards*, and the sheath of the vessel will be exposed. Open this in the usual way, avoiding the small branch of the internal cutaneous nerve which crosses the artery at this spot. Pass the aneurysm needle from within outwards to avoid injuring the vein which lies to the inner side of, and a little posterior to, the artery. *In Hunter's canal* the same line as the above indicates the course of the vessel (Fig. 108, b). Place the limb as before, and make an incision three or four inches long in the line of the artery in the middle third of the thigh. Divide the superficial and deep fascia, and the sartorius will be exposed. It may be known by its fibres running downwards and inwards. Draw the muscle to the *inner* side, and the poneurotic covering of Hunter's canal known by its strong transverse fibres) will be seen. Divide it on director, and the artery will be found lying between the vastus nternus on the outer side and the adductor longus and magnus n the inner side. The vein is behind and a little external to the rtery. The long saphenous nerve crosses the artery from the uter to the inner side. Pass the aneurysm needle from without wards, keeping the point well applied to the vessel, as the vein this situation is usually very adherent to the artery. The *chief angers* after ligature are—1, gangrene; 2, secondary hæmorrhage;

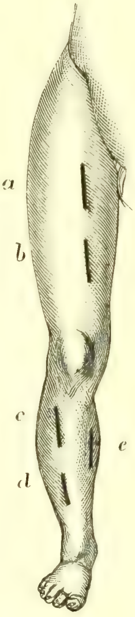


FIG. 108.—Lines of incision for ligature of arteries of lower extremity.

3, phlebitis and pyæmia from pricking the vein (see p. 281). The *collateral circulation* (Fig. 107) is carried on by the anastomosis of (a) the perforating branches of the profunda with the articular branches of the popliteal; (b) the descending branch of the external circumflex with the external articular branches of the popliteal and tibial recurrent; and (c) the artery of the great sciatic nerve with the internal articular branches of the popliteal.

The popliteal artery may be ligatured in its upper part for popliteal aneurysm. Place the limb on its outer side and make an incision about four inches long at the upper part of the popliteal space over the course of the artery. Divide the deep fascia and feel for the pulsation of the vessel at the inner margin of the semimembranosus. Hook the nerve outwards or inwards, and open the sheath well to its inner side to avoid the vein.

The posterior tibial artery.—*In the upper third.* Place the limb on its outer side, and make an incision four inches long parallel, and half an inch posterior, to the inner border of the tibia (Fig. 108, e). Divide only the skin and superficial fascia in the first incision to avoid injuring the long saphenous vein. Then divide the deep fascia and draw the gastrocnemius, if seen, backwards; cut through the tibial origin of the soleus, and the intermuscular fascia will be exposed. Divide this on a director, and the artery will be found lying on the tibialis posticus with the posterior tibial nerve to its outer side. Ligature of the posterior tibial in its upper third can hardly be required, except for a wound which should then be enlarged longitudinally until sufficient room is obtained. *At the ankle.*—Make a curved incision over the artery a finger's breadth behind and below the internal malleolus. Divide the superficial and deep fascia and the internal annular ligament, and the artery will be found between the tendons of the flexor longus digitorum and flexor longus hallucis with the nerve to its outer side. For *collateral circulation*, see Fig. 107.

The anterior tibial artery.—A line drawn from the inner side of the head of the fibula to midway between the two malleoli indicates the course of the vessel. *In the upper third* make an incision about five inches long in the line of the artery (Fig. 108, c) through the skin and superficial fascia, and look for the innermost white line, which indicates the cellular interval between the tibialis anticus and the extensor longus digitorum. Divide the deep fascia over this line on a director; hold the muscles apart by retractors, and the artery will be found on the interosseus membrane with the nerve to its outer side. *In the middle third* the artery lies between the tibialis anticus and extensor proprius hallucis, and the nerve lies on the artery. *In the lower third* the artery lies between the extensor proprius hallucis and the extensor longus digitorum with the nerve on its outer side. An incision in the line of the artery

(Fig. 108, d) and the separation of the muscles is all that is necessary to expose the vessel in either of these situations. For *collateral circulation*, see Fig. 107.

THE DORSALIS PEDIS ARTERY may require ligature for a wound on the dorsum of the foot. I have twice seen it tied for aneurysm of the vessel itself. Make an incision in a line drawn from midway between the two malleoli to the interval between the great and second toes; divide the skin and the superficial and deep fascia: the artery will be found between the extensor proprius hallucis and the innermost tendon of the extensor longus digitorum. As the artery sinks into the sole it is crossed by the innermost tendon of the extensor brevis digitorum. The anterior tibial nerve is on the outer side.

DISEASES OF THE VEINS.

THROMBOSIS, or clotting of the blood in a vein, is very common, and was formerly thought to be always the result of inflammation of the vein-wall. Hence, whenever a vein became thrombosed, the condition was spoken of as phlebitis. It is now known, however, that a thrombus may form in a vein without any inflammation of its walls, and that the presence of a thrombus is in some cases the cause and not the result of the inflammation. *The causes* of thrombosis may be considered under the following heads:—1. *Changes in the vein-wall*, such as may result from injury, inflammation, and degenerative processes, and such as often exist in the inner coat in varix. 2. *Changes in the blood*, such as occur in septicæmia and pyæmia and other affections in which there is a destruction of the white corpuscles, and the consequent setting free of the fibrin ferment contained in them. The exact nature of the changes in the blood inducing thrombosis is, however, not known, and the above explanation is at the best a mere theory. 3. *The presence of micro-organisms.* 4. *The retardation or arrest of the blood-stream*, as (*a*) when a ligature is applied to a vein; (*b*) when a vein is compressed by a tight bandage, tumour, or contraction of a cicatrix; (*c*) when the blood flows feebly through a vein owing to weak action of the heart induced by age, fevers, loss of blood, a varicose condition of the vein. 5. *The presence of a foreign body not covered by endothelium*, as a piece of ligature, an embolus, an already formed thrombus, or the protrusion of a new growth into the lumen of a vein.

Method of extension of the thrombus.—When once formed the thrombus may extend either with or against the blood-stream. As a rule, however, it takes the former direction, extending from the smaller to the larger veins, and in this way may at times reach the heart.

Appearances of a recent thrombus.—When the blood is at rest at the time of coagulation, as when a vein is ligatured, the thrombus will be red throughout, as both the coloured and colourless corpuscles equally become entangled in the fibrin. It will fill the whole lumen of the vein, and at first will be soft and gelatinous, and but loosely attached to the vein-wall. When, on the other hand, the clot is formed gradually whilst the blood is in motion, as when the clot is deposited on an unhealthy vein-wall, the clot is laminated, and firmly adherent to the wall, and will be either white or tinged with red, according to the rate at which it is formed. A *post-mortem* clot may be distinguished from the above in that it does not adhere to the wall of the vessel, nor as a rule entirely fill its lumen. It is never laminated, although it may consist of two layers, one white and one red.

Changes in the thrombus.—1. The clot may become converted, together with that portion of the vein in which it is contained, into a fibrous cord. Thus it first loses its red colour from the disappearance of the red corpuscles, then becomes firmer, more adherent to the wall of the vein, and finally indistinguishable from it. The minute changes which occur in this process are similar to those already described in the healing of an artery after injury (p. 114). 2. The clot may undergo calcification and become converted into a so-called vein-stone or phlebolith, which may either be found free, or attached to the walls by a pedicle. 3. The clot may soften and disintegrate, forming a pultaceous reddish material or a yellowish-red puriform fluid, the latter change being probably due to the action of septic micro-organisms. 4. The clot may shrink to one side of the vein, or become tunnelled by the blood, or it may be slowly carried away by the circulation without causing any mischief. The tunnelling of the clot is brought about by the gradual enlargement of the small vessels which normally permeate the clot during its conversion into a fibrous cord.

The effects of thrombosis are, 1. *Swelling and œdema* of the parts from which the affected vein returned the venous blood. This may completely or partially disappear, or it may remain permanent constituting the condition known as *solid œdema*, according to whether the lumen of the vein is or is not restored, or the collateral channels are sufficient for the requirements of the circulation. A good example of œdema from thrombosis is furnished by the so-called white leg, or *phlegmasia alba dolens*, so common after parturition as the result of the extension of the clot from the uterine veins through the iliacs to the femoral. 2. *Gangrene* occasionally occurs after the plugging of a large vein where the collateral circulation is insufficient to relieve the engorgement of the part, and is necessarily of the moist variety. 3. *Phlebitis*, or inflammation of the vein-walls, may ensue, and will take a simple or a spreading and suppurative form, according as the thrombus is of a simple or of a septic or infective nature. 4. *Embolism*, owing to a portion of a thrombus being swept away by the blood-stream and becoming lodged in a distant vessel. The way in which this detachment may take place is shown in Fig. 43, p. 146. If the thrombus is of a simple character, no harm may ensue; but if septic or infective, the embolus will also be septic or infective, and set up a like inflammation in the part where it becomes arrested. (See *Pyæmia*, p. 144.)

Signs.—When the deep veins are plugged, the only evidence of the thrombosis will be signs of obstruction to the circulation in the veins below, such as œdema or dilatation of the superficial veins. When, however, a superficial vein, as one of the saphenas, is affected, there will be a hard cord-like swelling in the situation of the vein, and some tenderness on pressure and feeling of stiffness on movement. Should inflammation of the vein follow from the presence of the thrombus, there will be in addition some heat and redness of the skin. (See *Phlebitis.*)

Treatment.—Absolute rest in the recumbent position is essential, lest a portion of the clot should become detached and lodged in an important organ, as the brain, or plug the pulmonary artery, and sudden death ensue. Where there is much œdema, the part should at first be elevated, and subsequently evenly and firmly bandaged.

PHLEBITIS, or inflammation of veins, may be divided into the simple, and the septic or spreading.

Simple phlebitis, formerly known as *adhesive phlebitis*, is a simple local inflammation of the vein-wall, and may terminate in resolution, obliteration of the vein, or more rarely in the formation of a localized abscess. *Causes.*—1. Injury of the vein-walls. 2. Simple inflammation of the surrounding tissues. 3. The formation of a non-infective thrombus in a vein. 4. Gout or the gouty diathesis. 5. Certain conditions of the system the exact nature of which is not known, the phlebitis being then spoken of as idiopathic.

Pathology.—The walls of the vein become infiltrated with leucocytes and swollen, whilst a thrombus, should such not already be present as the cause of the inflammation, will form in the interior of the vein. Changes similar to those already described under thrombosis may then occur in the clot. Thus the vein may become obliterated, or the thrombus variously disposed of and the calibre of the vein restored. Or pyogenic organisms may gain admission and suppuration may take place. The suppuration, however, does not spread unless the thrombus, the barrier to the organisms, is disturbed on the evacuation of the pus.

Symptoms.—There is the same cord-like swelling in the affected part of the vein as in simple thrombosis, but the skin, at least when a superficial vein is involved, is dusky red and œdematous, and pain is more severe on pressure and on movement. When a vein of large size is affected, there will be in addition signs of obstruction to the venous circulation. The gouty form is either associated with ordinary gouty inflammation in the foot or joints, or occurs with little or no evident provocation in persons of marked gouty constitution, or with a gouty inheritance. It is more especially characterized by its symmetry, apparent metastasis, and frequent recurrences.

The treatment is similar to that of thrombosis. Where there is much pain, a mixture of glycerine and belladonna may be smeared over the vein, or lead and opium lotion, or hot boracic poultices may be applied. Should an abscess form, it must be opened with antiseptic precautions, care being taken not to disturb the clots. Saline purgatives should be given, with potash, lithia, piperazine, and colchicum in the gouty, and the patient placed on low diet.

SUPPURATIVE PHLEBITIS is a spreading, infective inflammation of the vein-walls and tissues around. *Causes.*—It is due to an infective inflammation spreading to the vein-walls or to the softening of an infective thrombus. Thus, it is frequently met with in connection with compound fractures, ill-conditioned stumps, acute necrosis, osteomyelitis, diffuse cellulitis, malignant pustule, facial carbuncle, &c. It may also follow the opening of an abscess, the result of simple phlebitis, if the clots are disturbed and septic processes are allowed to take place in the wound. *Pathology.*—The coats of the inflamed vein become red, swollen, and in places soft and diffluent, and the thrombus softened into a purulent fluid, whilst micrococci are found both in it and in the vein-walls. These changes gradually extend up the vein, and should portions of the infective thrombus be carried away by the blood-stream, metastatic abscesses in distant parts and general blood-poisoning will result (*pyæmia*). *Symptoms.*—When a superficial vein is affected there is at first a cord-like swelling as in simple phlebitis, but redness and œdema of the skin soon supervene, followed by fluctuation in one or more situations in the course of the vein, and frequently by general blood-poisoning. When the deep veins are involved, the disease may not be suspected until signs of pyæmia set in, and the condition of the veins can then only with certainty be ascertained on a *post-mortem* examination being made. The *treatment* resolves itself into controlling or arresting, if possible, the infective inflammation in the part from which the suppurative phlebitis starts. Beyond this, little can be done, although, could the condition of the veins be diagnosed with certainty, amputation above the inflamed part might, before general blood-poisoning had supervened, save the patient's life. When the vein is superficial, cutting out a piece above the disease has been suggested; but cases to which such treatment would be applicable must be very rare, as the inflammation is seldom limited to a superficial vein.

VARICOSE VEINS.—A vein is said to be varicose when it is permanently and unequally dilated, and its coats have undergone certain degenerative changes. A varicose condition is most common in the veins of the lower extremities, and in the veins of the rectum and testicle (see *Piles and Varicocele*).

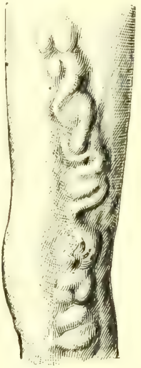


FIG. 109. — Varicose veins. (From Bryant's Surgery.)

The *causes* may be considered under the heads of increased intra-venous pressure, and changes in the vein-walls. A. *Increased intra-venous pressure* may be due to 1. Organic affections of the heart whereby the return of venous blood is impeded. 2. Obstruction to the circulation in the portal system, a cause chiefly affecting the hæmorrhoidal veins (see *Piles*). 3. Pressure upon the veins, such as may be exerted (*a*) by the gravid uterus or a tumour of the uterus or of the ovaries on the iliac veins; (*b*) by an aneurysm of the abdominal aorta on the inferior vena cava; (*c*) by fæcal accumulation on the hæmorrhoidal veins; (*d*) by a tumour in the groin on the femoral vein; (*e*) by an ill-fitting truss on the spermatic veins (see *Varicocele*); or (*f*) by a tight garter on the saphenous veins. 4. Long standing, which has a tendency to cause the accumulation of blood in the veins of the lower extremity. 5. Severe muscular exertion, whereby an increased amount of blood is driven by the contraction of the muscles from the deep into the superficial veins. Some authors consider this last the chief, if not the only cause of varicose veins of the lower extremities. They maintain that the pressure of the blood first produces a dilatation of the superficial veins where the intermuscular veins empty into them; that this dilatation being frequently repeated becomes permanent; that the valves in consequence are unable to close and protect the veins, and being thrown out of use gradually undergo atrophy, whilst the weight of the column of blood, from the inefficiency of the valves, becomes further increased, and the veins still further dilated. B. *Changes in the vein-walls.*—These consist principally in an hereditary weakness, want of muscular tone, and inflammatory softening of the walls. Varicose veins are more common in men than in women, owing to their more frequent exposure to the exciting causes. Women, however, are peculiarly liable to them during pregnancy.

Pathology.—A varicose vein is lengthened, dilated, and frequently tortuous (Fig. 109), the dilatation being especially marked where the intermuscular veins open into the superficial, and at the situation of the valves. The middle, and to a less extent the outer coat, are often greatly thickened by the formation of fibrous tissue, but the inner coat shows little change. In the dilated portions immediately above the valves the coats, on the other hand, may be found greatly thinned, so that the vein may give way at these situations. The valves themselves, from the dilatation of the veins, cease to be of service, and become atrophied and frequently reduced to mere ridges or fibrous cords. Thus the intravenous pressure in the segment below is increased as the column of blood in the upper part of the vein is no longer supported by the valves. The deep veins are generally involved in the varicose condition, and the smaller radicals returning the blood to the varicose vein from the skin often share in the dilatation. The skin, in consequence of the obstruction to the venous return, becomes congested and chronically inflamed (*varicose eczema*) and frequently gives way, producing an ulcer (*varicose ulcer*); whilst at times the pressure of the vein causes thinning of the skin, and this, with the wall of the vein, may yield, and hæmorrhage result. When the valves have been destroyed, the hæmorrhage may be very severe, and even terminate in death, as the blood sometimes flows backwards from the heart through the proximal end as well as the distal end of the vein. Thrombosis at some part of the vein is of frequent occurrence.

The *symptoms* usually complained of are fatigue and a sense of fulness of the limb after exercise or long standing, and perhaps cramp, coldness of the feet, swelling and œdema of the ankle, and numbness of the leg. Sometimes there is deep-seated pain. The tortuous vein or veins meandering up the leg is a characteristic sign which cannot be mistaken. When the smaller radicals are affected bluish clusters of minute veins are visible here and there, especially about the ankle and knee.

The *treatment* may be palliative or radical. *Palliative treatment* consists locally in supporting the dilated vein by an elastic stocking or by a Martin's or an ordinary bandage, and reducing the hours of standing where possible. The bowels at the same time should be regulated, and the general health improved by tonics, iron, &c. *Radical treatment* should be undertaken under the following circumstances:—1, when a vein appears likely to burst; 2, when there is a knotted mass of large veins in one or more situations giving rise to much pain and inconvenience; 3, when an intractable ulcer is present; and 4, when the varicosity is chiefly confined to a single vein. Many methods of operating have been proposed, some highly dangerous. With modern antiseptic precautions, the *excision* of a portion of the vein after a ligature has been applied above and below is the best and most certain method of radical cure. A small incision is made over the vein, the vein neatly dissected out for an inch or so, a ligature applied as high up and a second as low down as possible within this limit, the vein between the ligatures excised, and the little wound carefully united by sutures. Five or six similar incisions, or more if necessary, are made along the course of the varicose vein. When a mass of tortuous veins is the source of trouble, it should be dissected out, ligatures having been previously applied to the larger veins leading from the mass. After the operation the patient should be kept at rest in the recumbent position to prevent a portion of the thrombus becoming detached and the consequent danger of embolism in vital organs; whilst the strictest precautions should be taken to keep the wound aseptic, lest suppurative phlebitis ensue.

NÆVUS.

There are two chief varieties of nævus, the capillary and the venous, but both forms may be combined.

THE CAPILLARY NÆVUS or *plexiform angioma* consists of a mass of dilated and tortuous capillaries bound together by a scanty amount of connective tissue. These nævi are most common on the head, neck, face and chest; and occur as small, flat, or slightly-elevated, red or purplish-red patches on the skin or mucous membrane. Sometimes they are spread out as a thin layer covering perhaps the greater part of one side of the face, and are then known as *port-wine marks*. The blood can be pressed out momentarily, but returns when pressure is removed. Their rate of growth varies; sometimes it is quick, at other times it is slow; or they may remain stationary, or disappear spontaneously. *Treatment.*—The smaller nævi may readily be destroyed by nitric acid or ethylate of sodium. Those known as "port-wine marks" should be left alone, or under some conditions they may be scarified.

THE VENOUS NÆVUS or *cavernous angioma* consists of a number of cavernous spaces lined with endothelium and communicating with each other, and with the arteries on the one hand and the veins on the other. These nævi form distinct tumours bound together by delicate connective tissue sometimes containing fat. The blood in them is of a dark venous colour. They are generally subcutaneous, but may likewise occur beneath a mucous membrane. They are always congenital. They appear as irregular, nodular, soft, compressible tumours, easily emptied by pressure, but quickly refilling, and swelling up on coughing or crying. When under a mucous membrane they are of a purplish-blue colour. The skin or mucous membrane covering them may be natural, or it may be affected with the capillary variety of nævus. Their favourite seats are the lips, cheeks, scalp, organs of generation, back, and nates. They may gradually increase in size, remain stationary, or undergo a spontaneous cure.

Treatment.—The indications are to remove or to destroy the nævus with as little scarring as possible. This may be done by, 1, excision with the knife; 2, ligature; 3, coagulating injections; 4, setons; 5, electrolysis.

1. *Excision with the knife* is a rapid, painless, and effective method, and where, as in the lip, by removing a V-shaped piece a mere linear scar is left, is, perhaps, the best. To avoid hæmorrhage, however, the incision should be made wide of the growth.

2. *Ligature* is a sure, simple, and safe method, but is painful, slow, and leaves a scar. The ligature may be applied in several ways. All that can here be said is that the ligature should consist of whip-cord or China twist; that it should be applied with a nævus needle, either subcutaneously, or, if this is impracticable, through an incision made in the skin round the nævus; and that it should be tied tightly in a reef knot to ensure complete strangulation.

3. *Coagulating injections.*—The materials most often used are perchloride of iron, carbolic acid, and chloride of zinc. Only a drop or two should be injected, as otherwise sloughing may occur, or the coagulation may spread to the blood in the veins, and embolism, resulting perhaps in sudden death, may ensue. To avoid this accident the base of the nævus must be compressed by a clamp or a ligature during and for a short time after the operation. Injection is, at the best, a dangerous method.

4. *Setons.*—A simple thread, or one soaked in perchloride of iron, passed through the nævus and left in for a week, may effect a cure by causing adhesive inflammation. This method is sometimes useful where others are inapplicable.

5. *Electrolysis* is indicated when it is important to save the skin and reduce the scar to a minimum, as in venous nævi about the face. It consists in passing two or more needles into the nævus in different situations, and sending a weak constant current through them; or better, passing needles connected only with the negative pole of the battery into the nævus, and rubbing a rheophore connected with the positive pole over the skin of some other part of the body. Should bubbles of gas escape the current must be reduced in strength. Before removing the needles from the nævus the current should be reversed for a few seconds in order that the coagulum formed around the needles may not be disturbed and bleeding from the punctures ensue. The operation must be repeated many times, as if too strong a current is used sloughing will take place.

ARTERIAL VARIX, or a dilated, tortuous and irregularly pouched condition of an artery similar to that of a vein in varix; CIRSOID ANEURYSM, or a pulsating tumour composed of several lengthened, dilated and pouched arteries, and nearly always situated on the scalp; and ANEURYSM BY ANASTOMOSIS, or a localized dilatation of arteries, veins and capillaries,—are all too rare to require description here. Excision after ligature of the supplying vessels is perhaps the best treatment.

DISEASES OF THE LYMPHATICS.

LYMPHANGITIS or inflammation of the lymphatic vessels is generally associated with more or less inflammation of the lymphatic glands. *Causes.*—The most common cause is the absorption of septic or of infective products from a wound, which, however, is often very trivial, such as a simple scratch, abrasion, sting, or puncture; more rarely, the inflammation may follow upon mere irritation of the skin, as a chafe of the heel, excessive friction, or sun-burn. *Pathology.*—The walls of the lymphatics become infiltrated with cells, swollen, and softened, whilst the endothelium is shed, and the lymph contained in the vessels often undergoes coagulation. The inflammation spreads to the surrounding tissues, but seldom higher in the course of the lymphatics than the first set of glands, which also become swollen and infiltrated and arrest the further absorption of the septic products. It may *terminate* in resolution, or in suppuration in and around the glands, or more rarely around the lymphatics themselves. Sometimes the septic products appear to escape the glands, and general blood-poisoning ensues. *Symptoms.*—In severe cases, lymphangitis generally begins with a chill or rigor, followed by high temperature and fever, and perhaps vomiting and diarrhœa. Red lines, when the superficial lymphatics are affected, are seen running from the wound to the nearest lymphatic glands, with here and there erysipelatous patches of redness. There is generally pain and tenderness, especially in the region of the swollen glands, and swelling and œdema, sometimes of the whole limb. It may be diagnosed from phlebitis by the redness being superficial and in the course of the lymphatics, not in the course of the veins, by the absence of the cord-like and knotty feel of plugged veins, and by the presence of glandular enlargement; from erysipelas by the redness having no defined margin, and generally running in lines. The *treatment* consists in attending to any wound or abrasion, allaying other sources of irritation that may be present, and placing the inflamed part at rest in an elevated position. Hot fomentations or poultices, or glycerine and belladonna may be applied, and abscesses should be opened as soon as they form. If any swelling is left, pressure in the form of Scott's dressing or ammoniacum and mercury plaster may be used to disperse it.

LYMPHATIC VARIX OR LYMPHANGIECTASIS is very rare. It is attended by a condition of elephantiasis of the parts where the lymphatics are blocked. When the superficial vessels are affected, "the varix first appears in the form of small elevations, giving the skin an appearance which has been compared to the rind of an orange. It subsequently takes the form of little vesicles, covered with a thin layer of dermis." (Erichsen.) At times the dilated lymphatics form distinct tumours (*Lymphangiomata*). *Treatment.*—Slight elastic pressure, and protection from injury or irritation.

LYMPHATIC FISTULA OR LYMPHORRHŒA, though exceedingly rare, is a condition sometimes met with, and more especially in the groin, scrotum, or labium. It is said to be due to a wound of a lymphatic, or to the giving way of a varicose lymphatic, but the cause is not clearly understood.

LYMPHADENITIS, or inflammation of the lymphatic glands, may be acute, subacute, or chronic.

Acute and subacute inflammation is nearly always secondary to inflammation of the parts from which the afferent lymphatics proceed. Indeed, in most inflammations, there is some tenderness of the neighbouring glands. Not infrequently, however, the glands in the groin become enlarged without any discoverable irritation within the area from which they receive their lymph. In such cases there is generally a history of a strain, as from lifting heavy weights, or of over-exertion, as from a long walk. The explanation is probably the engorgement of the gland with lymph in the case of a strain from rupture of some of the efferent lymphatics, or in the case of over-exertion by more lymph being pumped into the gland from the muscular interspaces than can escape by the efferent vessels. The lymphatic vessels themselves, although the glands may become extensively involved, and even suppurate, often escape. The inflammation, however, rarely proceeds further in the course of the lymphatics than the first series of lymphatic glands, although it often spreads to the surrounding tissues (*peri-lymphadenitis*). The changes in the inflamed gland are like those of other inflammations. The whole gland is enlarged, the vessels being dilated and the lymph-sinuses crowded with cells. Micro-organisms, similar to those found in the inflammatory lesion giving rise to the lymphadenitis, have been discovered in the glands. The *signs* are tenderness, heat, pain and swelling, followed by redness of the skin and œdema. The gland, at first moveable, becomes fixed, and if the process runs on into suppuration, the usual signs of an abscess ensue. Familiar examples of lymphadenitis are seen in the bubo of gonorrhœa, in the tender glands of erysipelas, and in the suppurating bubo of soft chancre. The *treatment* consists in subduing the inflammation of the part from which the lymphatics proceed, painting the glands with glycerine and belladonna, applying a hot poultice, and, if suppuration has occurred, in making a free incision. If suppuration threatens the glands may be dissected out.

Chronic lymphadenitis is very common in strumous children, especially in the neck. The affection of the glands can frequently be traced to some exciting cause, as the irritation of pediculi on the head, eczematous affections about the mouth, enlarged tonsils, or carious teeth. In other cases, it depends upon the presence of the tubercle bacillus. (See *Tubercle*, p. 44.) The glands slowly enlarge, and become infiltrated with small round cells; whilst in the tuberculous cases, non-vascular areas containing giant-cells, lymphoid corpuscles, and tubercle bacilli are found. The enlargement may subside, or the inflammatory products may caseate, and suppuration occur in, or in and around the gland; at times, the caseous mass may dry up and become cretaceous, or atrophy or fibroid thickening may ensue. In rare instances it is said the tubercle may become disseminated, leading to general tuberculosis. *Signs.*—The glands, when those of the neck (the most common situation) are affected, become enlarged on one or both sides of the neck, without pain. They are at first distinct and moveable, but later often coalesce and become adherent to the surrounding parts. After a time, they may soften and break down; the skin then becomes adherent and red, gives way, and a curdy pus is exuded. After the abscess has thus opened, a portion of the broken-down gland may be seen in the floor of the ulcer, the edges of which are bluish-pink, and undermined. (See *Tuberculous Ulcers.*) The ulcers are very indolent, and when finally healed, leave characteristic raised, puckered, pinkish-white scars. Concomitant signs of struma or tubercle are frequently present. *Treatment.*—Any source of irritation, such as pediculi, carious teeth, &c., should be sought and removed, and the patient, if tuberculous, treated as indicated at p. 48. The glands had better be left alone, unless suppuration threatens, when they should be removed. If an abscess has already formed it should be opened early to prevent scarring. This may be done by a small incision, after which the capsule of the gland may be cleared out by a Volkmann's spoon. Should an indolent ulcer or sinus remain, as often happens if the abscess is allowed to burst spontaneously, it should also be scraped with a Volkmann's spoon and its edges destroyed by nitrate of silver or potassa fusa, or better, cut away.

LYMPHADENOMA, or non-inflammatory enlargement of the lymphatic glands, consists of a simple hypertrophy of the gland tissue, especially of the fibrous stroma of the gland, and must be distinguished from the enlargement associated with *leukæmia*, which is characterized by an increase of the white corpuscles of the blood, and a general hypertrophy of the adenoid tissue of the body, especially of the spleen. The *cause* of lymphadenoma is unknown. One or two glands only may be affected (*simple lymphadenoma*), or many of the glands, especially those in the neck, axilla, and groin, or, indeed, all the glands of the body, together with the adenoid tissue in the spleen and other organs (*Hodgkin's disease* or *general lymphadenoma*). The enlargement differs from that of the inflammatory affections, in that the glands remain free and distinct, and form smooth, rounded or egg-shaped, firm, elastic, and generally painless swellings, which, as a rule, do not suppurate. When one or two glands only are enlarged, the general health is not affected; but when many are involved, and especially when the condition is acute, the patient rapidly emaciates, becomes anæmic, the spleen enlarges, diarrhœa or dropsy may set in, and death usually results from exhaustion, or, it may be, from the pressure of the enlarged glands upon the trachea, bronchi, or some vital organ. *Treatment.*—Where one or two glands alone are enlarged they may be removed; but where large numbers are affected, no surgical treatment is of any avail, although if a gland is pressing upon the trachea, &c., it may be removed, or tracheotomy performed. Arsenic, in increasing doses, may be given internally, with iron and cod-liver oil, or chloride of calcium in ten-grain doses may be tried.

LYMPHO-SARCOMA is the term sometimes applied to primary sarcoma occurring in a lymphatic gland. (See *Sarcoma*, p. 71.)

DISEASES OF NERVES.

NEURITIS, or inflammation of nerves, occurs in the sheath or connective tissue binding the nerve-fibres together, and is therefore a perineuritis, or interstitial neuritis, and not an inflammation of the nerve-substance. The term is, however, also used where there is no inflammation but primary degeneration of the nerve-fibres. *Causes.*—Injury, cold, rheumatism, syphilis, tubercle, lead-poisoning, gout, diphtheria, alcoholism, and fevers. The different poisons, lead, diphtheria toxin, alcohol, tubercle, and other bacterial poisons lead to primary (Wallerian) degeneration, without previous inflammation. *Pathology.*—In true inflammation, the nerve appears slightly red and swollen, and later infiltrated with inflammatory exudation. In the more chronic cases the sheath and interstitial connective tissue appear thickened, whilst the nerve-fibres are more or less atrophied. When following an amputation, partial division with laceration, or gunshot injury, the inflammation generally spreads up the nerve from the seat of injury (*ascending neuritis*). In the degenerative type the axis-cylinders break up, the myeline sheath disappears, and the nerve becomes atrophied or functionally inactive. *Symptoms.*—There may be tenderness on pressure, or continuous pain with exacerbations, in the course of a nerve and its peripheral branches, tingling and numbness in the part supplied by it, and occasionally spasm of the muscles. The pain is generally worse at night, and increased on movement. At times the nerve may be felt to be swollen, and there may be loss of sensation or muscular paralysis in the part it supplies. The acute cases are attended with slight fever. In the traumatic form, pressure at the seat of injury, or over the bulbous end, may cause great pain and muscular spasm.

Treatment.—The cause, if possible, should be removed, alcohol forbidden, and appropriate remedies given if there be gout, syphilis, or signs of lead-poisoning, &c. Locally hot fomentations or leeches, or belladonna and glycerine may be applied, and later, blistering fluid along the course of the nerve. Absolute rest of the part supplied by the nerve is imperative. In the traumatic form following amputation, stretching the nerve relieves for a time; but cutting out the bulbous end, division of the nerve, or resection of a portion, though said to do good, have, in my experience, failed to cure. Percussion of the nerve is well spoken of by some.

NEURALGIA is the term applied to pain, generally of a paroxysmal and violent character, in the course or distribution of a sensory or mixed nerve. The *causes* of neuralgia are very various. Thus, it may be due to—1, pressure on a nerve by a tumour or aneurysm, or involvement of its end in a scar; 2, the presence of a foreign body in a nerve; 3, inflammation of a nerve from injury, exposure to cold, &c.; 4, irritation or injury of another nerve or its endings, transferred or reflected—*e.g.*, supra-orbital neuralgia due to carious teeth, pain in the back consequent on uterine disease; 5, some constitutional condition, as debility induced by excessive child-bearing, mental depression, hysteria, influenza, malaria, &c.; 6, disease of the central nervous system; 7, unknown causes. *Symptoms.*—The usual sign is pain in the distribution or course of a nerve or of several nerves, generally violent, shooting, paroxysmal, and tingling. At times it may be attended with spasm of the muscles, hypersecretion of the glands and derangements of pigmentation of the hair and skin. The pain, except when it depends upon neuritis, may often be relieved by pressure. It is most common in the fifth nerve, trigeminal neuralgia (*tic douloureux*), in the sciatic nerve (*sciatica*), and in the intercostal nerves (*pleurodynia*). At other times it is localized to an organ, as the testis or the breast, or to a joint. A severe form of trigeminal neuralgia known as *epileptiform neuralgia* or *incurable tic*, may affect one or more of the branches of the fifth nerve. The paroxysms are of short duration, but of a most excruciating character; they recur at varying intervals, and are brought on by the slightest cause, as pressure over the bony canal through which the nerve emerges on the face, a draught of cold air, taking food, &c. The pathology of it is quite unknown. *Simple neuralgia*, *i.e.*, pain, the cause of which is not apparent, often simulates organic disease. Thus, pain in the course of an intercostal nerve may simulate pleurisy; neuralgia in a joint, joint-disease. It may be distinguished from such by the absence of signs of inflammation, of deep-seated pain, and of swelling and deformity; by the presence of increased cutaneous sensibility; and often by the fact that firm pressure relieves it. *Sciatica*, or pain in the course of the sciatic nerve, may be a simple neuralgia, depending upon some central and unknown cause; or it may be due to a neuritis set up by cold, or a blow causing local effusion in the nerve-sheath or an adhesion between the nerve and its sheath, a spiculum of bone or exostosis pressing upon the nerve especially in its passage through the great sciatic notch, a foreign body in the thigh, pelvic inflammation in connection with pregnancy, or the pressure of a tumour. When due to a neuritis it is accompanied by more or less muscular atrophy.

Treatment.—The first indication is to remove the cause, for which a careful search should be made. Thus, carious teeth should be extracted, foreign bodies removed, &c.; the general health improved by tonics, iron, quinine, fresh air, &c.; and gouty, rheumatic, or other constitutional diatheses combated by appropriate means. When no cause can be discovered, the treatment must necessarily be empirical; and when one remedy fails, another must be tried. Thus, internally, quinine in large doses, arsenic, aconitine beginning with $\frac{1}{200}$ of a grain, nitro-glycerine in one minim doses of a one per cent. solution, croton-chloral, gelsemium, tonga, antipyrin, phenacetin, and phosphorus, may successively be given. Locally, the part may be painted with liniment of aconite or rubbed with ointment of aconitine; or the actual cautery, or small blisters applied over the course of the nerve; or morphia or osmic acid injected subcutaneously. In simple neuralgia of the sciatic nerve the continuous current with the positive rheophore applied over the sacro-iliac synchondrosis and the negative in a vessel of salt and water in which the foot is placed is often of great benefit. *Neurotomy*, or dividing the nerve, and *neurectomy*, or cutting a piece out of the nerve, have long been practised for obstinate trigeminal neuralgia, but are attended with but very temporary benefit. *Nerve-stretching* and *neurexaresis*, or extracting the nerve by torsion, hold out better prospects of success. *Nerve-stretching* consists in cutting down upon the nerve, catching it up with a blunt hook or aneurysm needle passed beneath it, and forcibly stretching both the proximal and distal ends. The strain that a nerve will bear without breaking of course varies with its size, but it is very considerable. The sciatic nerve, which is sometimes stretched for sciatica, is so strong that the patient can be lifted up from the table by it without its giving way. This nerve, however, may be stretched by what is called the bloodless method—*i.e.*, by extending the leg on the thigh, and forcibly flexing the thigh on the body. The effect upon the pain produced by nerve-stretching is variously supposed to depend on — 1, some alteration in the molecular elements of the nerve which may be transmitted to the nerve-centres; 2, some alteration in its vascular or nervous supply; 3, the breaking down of adhesions which may have formed around it. This operation is not infrequently practised for intractable trigeminal or epileptiform neuralgia. The relief it gives is unfortunately not always permanent, though considerable periods of immunity have been gained, and after the return of the pain the operation may be repeated. At any rate it appears to give more lasting relief than either neurotomy or neurectomy. *Neurexaresis* consists in slowly extracting by torsion as much of the nerve as can be got away. Relapses are reported to be less frequent than after nerve-stretching. Cases of epileptiform neuralgia that have resisted all other treatment, have, in several instances, been greatly benefited, if not cured, by the excision of Meckel's ganglion. In others the trunk of the fifth nerve or all its branches simultaneously have been divided, and the Gasserian ganglion has been removed. These very severe procedures have been followed by sloughing of the eye-ball. Slight injuries to the eye, such as the irritation of the conjunctiva by the antiseptic fluid in operations upon the fifth nerve and especially upon the first division, may lead to suppuration of the globe. It has been advised therefore to sew up the eyelids previous to operating. Hypnotic suggestion has been much practised abroad for the cure of neuralgia and allied affections, and percussion has given relief.

Methods of exposing the fifth nerve or its branches for the purpose of neurotomy, neurectomy, neurexaresis, or stretching.—These are numerous. A brief account of some of them only can be given.

(*a*) The supra-orbital branch of the first division is readily exposed by making a transverse incision through the tissues over it where it emerges through the supra-orbital notch which can usually be felt on the upper margin of the orbit.

(*b*) The second division may be exposed—1, where it emerges on the face, through the infra-orbital foramen; or 2, where it leaves the skull through the foramen rotundum. 1. To expose the nerve where it emerges on the face make a transverse incision over it a little below the margin of the orbit, cutting through the skin, orbicularis oculi and levator labii superioris. If there is any difficulty in finding the nerve pass a probe into the infra-orbital foramen; this will serve as a guide to it. The nerve is accompanied by the infra-orbital artery, which, if divided, should be tied. 2. To expose the nerve where it leaves the skull through the foramen rotundum make a transverse incision about a quarter of an inch below the margin of the orbit, and from the centre of this a second vertically downwards for an inch and a half. Carry the incisions to the bone, and the infra-orbital nerve will be exposed. Next open the front wall of the antrum with a trephine. Chip away with small curved bone-forceps the lower wall of the infra-orbital canal; the nerve will then be exposed as far as the back wall of the antrum. Perforate this wall with a small trephine and enlarge the wound with bone-forceps if necessary; the nerve can be traced across the spheno-maxillary fossa to the foramen rotundum, and can be here either stretched or divided, or a portion of it excised. *Meckel's ganglion* can now be removed if desired by clearing out the fat in which it lies just below the nerve in the spheno-maxillary fossa. The deep stage of the operation will be facilitated by an electric lamp or mirror on the operator's forehead. I have stretched this nerve and removed the ganglion several times, and much prefer the method here described to that of raising the periosteum and chipping away the upper wall of the canal. I am of opinion that the inflammation and sloughing of the globe which has followed operation on this branch of the fifth are dependent in a greater measure upon the disturbance of the contents of the orbit than upon the interference with the nerve. No inflammatory mischief of any kind has followed my operations, and the wounds have healed without any trouble.

(*c*) The third division, or its inferior dental, gustatory, or auriculo-temporal branch may be exposed as follows:—The *inferior dental* is best dealt with through the mouth. I have stretched it in this way a number of times, and can speak in the highest terms of the method. The septic troubles, necroses, &c., to avoid which many elaborate operations have been undertaken, are in my experience purely mythical, and I consider such operations quite unjustifiable. Open the mouth with a gag; make an incision through the mucous membrane from the last molar tooth in the upper to the last molar in the lower jaw. Insert the finger between the internal pterygoid muscle and the bone; feel for the tongue of bone at the entrance of the inferior dental foramen; pass an aneurysm needle having a very short curve into the wound; hook up the nerve and stretch or divide it, or excise a portion if desired. The wound heals in a few days without any trouble; there is no external scar, and the patient may be about his work within a week. The *gustatory branch* may be stretched through the same incision as that given above; or through a transverse cut made in the mucous membrane between the last molar tooth and side of the tongue. The *auriculo-temporal* is readily reached by a vertical incision over the temporal artery extending upwards for an inch and a half from the zygoma. The *trunk of the third division* may be exposed as follows:—Make a curved incision from the root of the pinna across the temporal muscle to the middle of the malar bone; turn down the flap; divide the temporal fascia; saw through the zygomatic arch in front of the ear and through the middle of the malar bone, and turn down the zygoma and masseter with Stenson's duct and branches of the facial nerve. Excise the coronoid process with the lower portion of the temporal muscle. Draw down the external pterygoid till the foramen ovale is exposed. The trunk of the third division may here be stretched, avulsed, or divided. Or the foramen ovale and foramen rotundum may be laid into one by bone-forceps and trephine, and the trunks of both the second and third divisions be thus attacked intracranially. The *Gasserian ganglion* may at this stage be exposed by trephining the great wing of the sphenoid external and anterior to the foramen ovale, laying that foramen into the trephine hole by cutting away the intermediate bone with forceps, and raising the dura with an elevator. The posterior part of the ganglion can now be cut away by means of forceps, sharp spoons and curettes. I have never removed the ganglion myself, nor advised its removal, since not only is the operation attended with grave risk, but as far as I can learn in every case in which it has been performed a relapse has occurred. The mortality appears to be about 10 per cent.

TUMOURS OF NERVES, whatever their structure, were formerly called neuromata. This term, however, should be restricted to that rare form of tumour composed of nerve elements; whilst other tumours of nerves should be called fibromata, sarcomata, &c., as in other situations, according as they consist of fibrous tissue, sarcoma elements, &c.

The true neuromata are exceedingly rare, and call for no further mention.

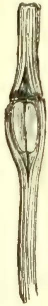


FIG. 110. — A median nerve with a tumour over which the filaments are spread out. (St. Bartholomew's Hospital Museum.)

The fibromata, though, like other tumours of nerves, far from common, are the variety most frequently met with. They grow from the connective tissue either of the sheath or of its prolongations within the nerve; in the latter case the nerve-fibres will be spread out over them (Fig. 110). They are generally single, or there may be several on the same or on different nerves. *Signs.*—They occur as painful, more or less globular tumours in the course of a nerve, and are often accompanied by numbness, tingling, and perhaps muscular spasm in the part it supplies. They can be swayed from side to side, but cannot be moved up and down in the long axis of the nerve. Another form of fibrous tumour connected with nerves is the so-called painful subcutaneous tumour of Paget, which occurs as a small nodule beneath the skin, and causes the most exquisite pain when handled. The *treatment* consists in dissecting the tumour out, or if this is impracticable, removing it along with the affected portion of the nerve, and then suturing the divided nerve-ends. If the divided ends cannot be brought into contact an attempt may be made to graft a piece of nerve between them. The painful subcutaneous tumour is readily removed by dissection.

The myxomata are the next most common tumours of nerves, and give rise to similar symptoms.

The sarcomata, though more rare, may also be met with in nerves, and are sometimes multiple.

CONVULSIVE OR MUSCULAR TIC, or histrionic spasm as it is sometimes called, is a convulsive twitching of the muscles of the face, due to some form of irritation of the facial nerve the nature of which is not known. It is at times associated with neuralgia of the fifth nerve. Stretching the facial nerve just after it emerges from the stylo-mastoid foramen may be undertaken in severe cases, as, for instance, when the spasm interferes with sleep, &c., and with a fair prospect of success.

PERFORATING ULCER OF THE FOOT.—Though the pressure of a corn can generally be traced as the exciting cause of the ulcer, it would appear in many cases to depend upon changes in the peripheral nerves, leading to trophic changes in the part and a consequently lowered resisting power of the tissues to injury or pressure. It is sometimes associated with locomotor ataxia, at times with diabetes, leprosy, and spina bifida. The usual situation of the ulcer is the ball of the great or little toe. It is attended with but slight inflammation, and probing causes hardly any pain. It may lead to destruction of the metatarso-phalangeal joint, necrosis of the bones, and perhaps complete perforation of the foot; it is sometimes the starting point of gangrene. There is usually local sweating, lowering of temperature, and impairment of sensation of the foot and lower third of the leg. The patella-reflex is often lost. *Treatment.*—Though the ulcer will often yield to prolonged rest, the removal of dead bone, scraping, taking off pressure by cutting a hole in a thick cork sole, and other local treatment, amputation is sometimes called for. Nerve-stretching has also been recommended. Relapses are common.

SURGICAL DISEASES OF THE SKIN.

VERRUCÆ OR WARTS, are small excrescences on the skin formed by the hypertrophy of the papillæ and epidermis. The following varieties are described. 1. *Verrucæ vulgares*, or common warts, so frequent on the hands of children and young adults. 2. *Verrucæ seniles*, which occur as brownish elevations generally about the back, neck, and arms of old people. 3. *Verrucæ necrogenicæ*, common on the hands of dissecting-room porters and morbid anatomists, and often tuberculous. 4. *Venereal warts*, met with on the genitals as the result of the irritation of gonorrhœa or other irritant discharges. 5. *Soot warts*, which affect the scrotum of chimney-sweeps, and are frequently the starting point of "sweep's cancer." 6. *Congenital warts*, which take more the form of irregularly-shaped growths than of true warts, are frequently pigmented and hairy (*nævi verrucosi*), and at times occupy large portions of the surface corresponding to the distribution of certain cutaneous nerves (*papillomata neurotica*). *Treatment.—Common warts* often disappear spontaneously. They may be readily destroyed by such caustics as salicylic, acetic, and nitric acid, or nitrate of silver. *Venereal warts* may be snipped off with the knife or scissors. *Senile warts*, when large, had better be excised or curetted. The *soot wart* ought to be removed at once by the knife. The acid nitrate of mercury is highly spoken of as an application to *verrucæ necrogenicæ*. In the *pigmented* and *hairy wart* shaving away the skin to the roots of the hair bulbs or electrolysis, if the wart is not too extensive, may be employed.

CLAVUS.—Corns consist of localized thickenings of the epidermis, and although they may occur on any part of the body that has been subjected to intermittent pressure, are most common on the feet, where they are produced by tight or badly-fitting boots, especially when high heels have been worn, and the weight of the body has thus been unnaturally thrown upon the toes; they are for the same reason frequently met with in talipes equinus. Two varieties are described, the *hard*, occurring on exposed parts, particularly the dorsum of the toes, and the *soft*, situated between the toes, where in addition to pressure, the parts are subjected to moisture. A hard corn, on section, is seen to be more or less conical; and it is the pressure of the apex of this cone upon the papillary layer of the corium that causes the pain. At times a bursa is developed beneath the corn. At other times suppuration occurs, and the pus being prevented from escaping by the hardened cuticle, gives rise to great tension, pain, and consequent inflammation of the skin and subcutaneous tissue around, and may even terminate in ulceration, which may extend deeply into the foot. *Treatment.*—A hard corn should be pared down, and then painted night and morning with salicylic acid and collodion. In the meantime all pressure should be removed by means of a corn pad, or a hollow moulded in the leather of the boot. Soft corns should be allowed to become dry and hard by separating the toes with cotton-wool, and dusting them with a mixture of oxide of zinc and iodoform, or other form of astringent and antiseptic powder, and then treated in the same manner as hard corns. Should suppuration occur beneath a corn, an incision through it to evacuate the pus will give immediate relief, or the corn may be pared down with a sharp scalpel till the pus is reached without giving any pain. In the old, in whom senile changes have occurred in the vessels, gangrene may result from paring a corn too closely.

HORNS (*cornua cutanea*) consist of hypertrophied papillæ covered by hardened epithelium. They may spring from the interior of a sebaceous cyst or from a wart, and are apt to degenerate into epithelioma at their base. They are most common on the face and scalp. Free removal is the treatment.

MOLLUSCUM CONTAGIOSUM is the name given to one, or generally more, small, wart-like, pearly, semi-globular, umbilicated swellings, varying in size from a pin's head to a pea. They are most frequently met with on the skin of the face, lips, eyelids, and breast. They contain a little mass of closely aggregated bodies like swollen starch grains, called "molluscum bodies," which are probably derived from the epidermal cells. In that they are met with on the infant's lips and mother's breast they are thought to be contagious. They must be distinguished from molluscum fibrosum, the name applied to soft fibromata of the skin. *Treatment.*—They should be incised, the bodies pressed out, and the little cavity left touched with caustic.

CHILBLAINS are local congestions of the skin caused by exposure to cold and damp in young persons with a feeble circulation. They commonly occur on the fingers and toes; less frequently on the nose and ears. They present a sharply-defined, bluish-red blush of erythema, disappearing on pressure, and slowly returning. In severe cases the skin becomes dusky and purplish in colour, and the cuticle gives way, leaving a raw surface (*broken chilblains*). They are attended with intolerable itching. *Treatment.*—The general circulation should be promoted by exercise and good food, and the local by stimulating liniments, the parts being kept warm by woollen gloves or socks. When the chilblain is broken, it may be dusted with iodoform, or dressed with oxide of zinc or soap-plaster. Arsenic internally appears sometimes to be of service.

ONYCHIA, OR ONYCHIA MALIGNA, as in severe cases it is sometimes called, is a chronic unhealthy inflammation of the matrix of the nail, attended with ulceration and a horribly fœtid purulent discharge. It is most frequently met with in strumous children as the result of a crush of the finger or some slight injury; but it may depend on syphilis, or more rarely on eczema or psoriasis of the matrix, or its inoculation with the parasite of ringworm. In a typical case the end of the affected finger is swollen and inflamed, and of a dusky or livid red colour, whilst the nail is blackened, shrunken, loosened from its matrix, surrounded by a crescent of unhealthy ulceration, and bathed in a very fœtid discharge. It is exquisitely tender to the touch. In severe cases the ulceration may extend to the bone and neighbouring joint, and the last phalanx be lost. *Treatment.*—The nail, if black and shrivelled, should be removed by forceps, the wound powdered with iodoform or nitrate of lead, or dressed frequently with a lotion of liquor arsenicalis or nitrate of silver. In strumous subjects appropriate constitutional remedies must be given. If there is a suspicion of constitutional syphilis, the part should be dusted with calomel, or dressed with blackwash, and mercury or iodide of potassium given internally. In some inveterate cases it may be necessary to scrape or shave away the matrix of the nail, or destroy it by caustics.

FURUNCULUS, OR BOIL.—A boil is a circumscribed inflammation of the skin and subcutaneous tissue, terminating in gangrene of the central part, which is then cast off in the form of a slough, popularly called the core. Boils generally occur in crops, one coming out after the other has healed; or several small boils form around a larger central one. They are usually situated on the neck, nates, back of the hand, and back. Though most common in the young, they may occur at all ages. The *causes* are numerous. As predisposing may be mentioned change of habit, a too exclusive meat diet, diabetes, albuminuria, alterations in the blood depending on acute disease, the emanations of sewer gas, changes of season or air, and cachectic conditions however induced. The exciting cause is any local irritation, such as chafing of the neck by the collar, or of the nates in rowing, the irritation of morbid fluids in making *post-mortem* examinations, &c. But frequently no cause, either constitutional or exciting, can be discovered. The *Staphylococcus pyogenes citreus* or *aureus*, one of which is almost always present in boils, is the essential cause. *Signs.*—A boil begins as a red pimple usually with a hair in the centre, and as it increases in size forms a painful, dusky, purplish-red and conical swelling, with a flattened apex. The inflammation may at times subside, and the boil gradually disappear (*blind boil*). More often the cuticle separates at the apex, a vesicle forms, bursts, and leaves a yellow slough exposed, which is cast off as a central core through a single opening. *Treatment.*—A boil may sometimes be aborted by plucking out the central hair, injecting with carbolic acid, applying nitrate of silver, or painting it over with a thick layer of collodion. Should these fail, a boracic poultice or hot fomentations, and, where there is much pain, glycerine and belladonna may be applied, and after it has broken, a simple healing ointment. An incision may occasionally be necessary. The constitutional treatment consists in attention to hygiene, regulation of the diet and secretions, administration of tonics, &c. Arsenic, yeast (ʒj.) and sulphide of calcium (gr. $\frac{1}{6}$ to $\frac{1}{3}$) have at times been found useful.

CARBUNCLE is a spreading inflammation of the subcutaneous tissue involving, to some extent, the overlying skin and terminating in gangrene of the affected tissue, which is discharged in the form of sloughs. It differs from a boil in that it is of larger size, has a tendency to spread, and is flattened instead of conical; there is greater brawniness of the surrounding tissues; the skin gives way at several places instead of at the apex; the gangrenous tissue is discharged in the form of sloughs instead of as a core; and it is accompanied by severe constitutional symptoms. *Cause.*—Any vitiated state of the constitution, such as may be induced by too high or too poor living, gout, diabetes, albuminuria, typhus or other acute fevers, prolonged lactation, and the like. Friction and pressure are mentioned as exciting causes, and are said to explain the frequency of its occurrence on the nape of the neck, back, and nates.

The presence of the pyogenic micrococci is the essential cause. It is more common in men than in women, and does not usually occur till after the middle period of life. It is especially dangerous when associated with diabetes, and when it occurs on the face or scalp. In the former situation, suppurative phlebitis of the angular vein, with extension of the infective thrombi through the ophthalmic vein to the cavernous and other blood sinuses in the skull, and consequent meningitis or general blood-poisoning, is the danger to be apprehended. *Symptoms.*—It begins as a hard painful swelling, accompanied by fever, generally of a low type and with marked depression. The swelling rapidly spreads, and forms a flattened, generally more or less circular, elevation of the skin, surrounded by considerable brawny induration and redness. At first red, it soon becomes purplish-red, dusky or livid. Vesicles form over its surface, and on bursting, leave a number of apertures in the skin through which a greyish-yellow slough is seen. The apertures then coalesce, and the slough is gradually thrown off, leaving a granulating wound; or the inflammation continues to spread, and the patient may sink into a low typhoid or delirious state, and die of asthenia or of blood-poisoning (sapræmia, septicæmia, or pyæmia). *Treatment.*—The strength must be supported by fluid nourishment, and stimulants as indicated by the pulse and temperature; the patient should have abundance of fresh air, and should not, if it can be avoided, keep his bed. Opium should be given when there is much pain. Locally, a crucial incision was formerly a favourite practice, but it is attended with so much hæmorrhage that unless the patient's powers are good it should not be made. Some recommend the introduction of potassa fusa or the injection of carbolic acid into the carbuncle, and speak highly of both plans as a method of arresting its progress while still small. Others make a subcutaneous incision when there is much pain and tension; whilst the majority of surgeons apply heat and moisture in the form of a boracic poultice. Luke painted rings of a mixture of collodion and flexible collodion beginning at the periphery of the induration and narrowing the circle daily towards the centre; the contraction from without inwards gradually extrudes the slough. Scraping away the sloughs and diseased tissues with a Volkmann's spoon and afterwards swabbing with pure carbolic acid is recommended for preventing septic poisoning. I have tried this method and can speak well of it. The hæmorrhage attending the scraping is much less than might be imagined. Healing rapidly ensues. When the sloughs have separated or have been removed, the wound should be treated as a granulating ulcer.

Lupus vulgaris is a disease of childhood, and seldom begins after the age of puberty. It is characterized by the formation of yellowish-red nodules in the skin or mucous membrane, and subsequently by scarring and often great destruction of the affected tissues and much deformity. *Cause.*—It has been shown to be of the nature of a local tuberculosis depending on the presence of the tubercle bacillus. *Pathology.*—The deeper layers of the corium become infiltrated with small round cells, amongst which new capillaries are formed. In this granulation-like tissue are found non-vascular areas resembling in structure miliary tubercles, and in them giant cells and the tubercle bacillus have been discovered. The small-celled infiltration extends along the vessels, sweat-glands, sebaceous glands and hair-follicles, and may finally involve the whole of the corium. The granulation-like tissue may then either undergo atrophy and be partially absorbed without ulceration, though leaving, nevertheless, a permanent scar; or it may undergo caseation, and the cuticle giving way, break down into an ulcer.

Signs.—The disease begins as reddish or amber-coloured, semi-transparent, apple-jelly-like nodules, the colour of which does not completely disappear on pressure. The nodules later become slightly elevated, and several coalesce, forming larger nodules or tubercles, over which the cuticle forms slight scales. The centre of the patch may now undergo atrophy and partial absorption, leaving a slightly-depressed whitish cicatrix. In this way the disease may become cured; or while cicatrization is taking place in the centre the disease may continue to spread at the margins. Or the lupous patch may break down and ulcerate, the surrounding skin often becoming inflamed. The edges of the ulcer are raised, whilst its base is smooth, red, and spongy-looking. The ulceration may proceed gradually or rapidly, and extend through the skin or mucous membrane to the underlying structures, destroying, as when the nose is attacked, skin, mucous membrane, muscle, cartilage, in fact everything except bone. The favourite seat of lupus vulgaris is the face, especially the ala of the nose; but it may attack the skin and mucous membrane of almost any part. It is more common in females than in males. From tubercular syphilis, the affection for which it is perhaps most likely to be mistaken, it may be distinguished by the age at which it began, the history of the case, and the absence of concomitant signs of syphilis.

Treatment.—The lupous patch should be thoroughly scraped with a Volkmann's spoon, the scraping being continued as long as any soft lupoid material comes away, and until the tissues feel hard and resisting to the spoon. The actual cautery, or some form of caustic, should then be applied to the raw surface, or a skin graft applied. The wound should be dressed with iodoform or other antiseptic, and healing is quickly accomplished with comparatively little scarring. Any small lupoid tubercles around the main patch may also be scraped or touched with the galvano-cautery point. Internally, cod-liver oil, arsenic, or the phosphate or the iodide of iron, may generally be given with advantage.

Lupus erythematosus is a cellular new growth characterized by one or more circumscribed reddish patches covered by greyish or yellowish greasy adherent scales. *Pathology.*—The capillaries of the sebaceous follicles become dilated, and the tissues infiltrated with small round cells. The follicles then become enlarged and distended with sebaceous material, which exudes and forms greasy scales on the surface of the lupous patch. These scales, on removal, are found continuous with the plugs of sebaceous material filling the follicles. Later, the follicles are destroyed, and the infiltrating cells converted into cicatricial fibrous tissue. The *cause* is unknown, but it is believed to be tuberculous. It has not been proved to be either hereditary or contagious. *Signs.*—It begins most commonly on the cheeks or nose in the form of one or more erythema-like red patches, which fade momentarily on pressure, and are often attended with itching. The patches become covered with greasy scales continuous with the sebaceous matter in the enlarged follicles. They usually spread by their slightly raised edges, leaving dry, pale, depressed scars in their centre, which are productive of considerable deformity, but ulceration does not occur. The disease is nearly always symmetrical, affects most commonly the cheeks and nose, less commonly the ears, scalp, lips, backs of the hands and fingers, and after an apparent cure is liable to a relapse. It is most frequent in women, begins in young adult life, is very chronic in its course, and is often complicated by attacks of erysipelas. *Treatment.*—The general health should be attended to, and arsenic, cod-liver oil, or iron should be given if indicated. Very numerous applications for relieving the itching and promoting absorption have been recommended, such as mercurial plaster, iodine, and oleate of zinc; but the best method is linear scarification or scraping, which must be repeated from time to time for considerable periods.

Keloid is an overgrowth of the fibrous tissue of a cicatrix, and appears as a raised, firm but elastic, smooth, pale red, unsightly mass, taking more or less the shape of the scar. It may occur in any scar, those of mucous membrane as well as skin, but is perhaps most frequently met with after burns, and in the scars left on healing of tuberculous ulcers and abscesses. It would appear to depend upon an idiosyncrasy in the individual, since after removal the keloid condition nearly always returns when the wound heals. It is better, therefore, to leave it alone. Painting with iodine and linear scarification are advised.

Ingrowing nail is most frequently met with in the great toe as the result of wearing tight boots and of cutting the nails square. The tight boot presses the skin over the sharp corner of the nail on each side, and ulceration, attended by the formation of exquisitely tender and exuberant granulations, results, giving the part the appearance as if the nail had grown into the flesh. The condition is a very painful one, and troublesome to cure. The *treatment* consists in wearing square-toed boots, so as to provide plenty of room for the toes, and then pressing a piece of tinfoil or lint between the edge of the "ingrowing" nail and the overhanging portion of skin. Should this not succeed a longitudinal strip of nail should be removed, and the prominent granulations and redundant skin shaved away to the level of the nail, together with that portion of the matrix corresponding to the strip of nail removed. As the operation is excessively painful, it should be done under an anaesthetic, or the ether spray may be used, or the part injected with cocaine.

HYPERTROPHY of the toe-nail occasionally occurs as the result of neglect or chronic congestion of the matrix, and may assume the form of a horn. The *treatment* consists in cutting away the hypertrophied portion or in removing the whole nail.

SECTION V.

INJURIES OF REGIONS.

INJURIES OF THE HEAD.

Injuries of the Scalp.

CONTUSIONS OF THE SCALP are very common as the result of falls or blows on the head, and are frequently followed, especially in children, by extravasation of blood, and the consequent formation of a *hæmatoma* or blood-tumour. In new-born infants such tumours are of frequent occurrence in consequence of severe pressure on the head during birth, especially when instruments have been used, and are then known as *cephalhæmatomata*. The blood may be extravasated (1) between the aponeurosis and the pericranium; and (2) between the pericranium and the bone. In the latter situation the resulting tumour is generally circumscribed in consequence of the pericranium being firmly attached along the lines of the sutures; in the former it is generally diffuse, and in some instances extends over the whole of one side of the head. The diffuse form can only be mistaken for an abscess, from which, however, it may be distinguished by its sudden formation and the absence of signs of inflammation. The circumscribed, which gives rise to a soft fluctuating tumour with hard and often sharp margins, is sometimes very difficult to diagnose from a depressed fracture. In the case of the blood-tumour (Fig. 111, A) the hard margins (due to the coagulation of the blood at the circumference—the central part remaining fluid) are raised above the level of the surrounding bone, as may be detected by passing the finger along the scalp; while on pressing upon them with the finger-nail the blood may be displaced and the bone be felt beneath. As a rule, the blood becomes absorbed, but ossification at times occurs in the angle where the pericranium is raised from the bone. *Treatment.*—Under the use of evaporating lotions the more superficial hæmatomata will usually subside. It may sometimes be necessary, however, to aspirate those more deeply situated. If suppuration occurs a free incision should be made.

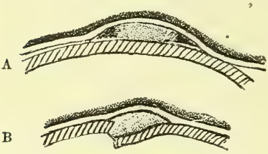


FIG. 111.—A. Section of a cephalhæmatoma; and B. a depressed fracture. The dark shading in A. represents the coagulated blood.

Wounds of the scalp vary in extent from a mere scratch to an extensive denudation of the bone, and, like other wounds, may be incised, lacerated, punctured, or contused. Though large portions of the scalp may be torn up from the bone, sloughing is very rare, as the arteries which supply the scalp run between the skin and the aponeurosis, and hence are contained in the flap. Scalp-wounds are frequently attended with sharp hæmorrhage; they are also often associated with fracture of the skull, search for which should always be made by passing the finger into the wound. Moreover, they are apt to be complicated by erysipelas or cellulitis, with the formation of pus between the aponeurosis and the pericranium, and where the bone has been much contused, by suppuration beneath the pericranium, in the diploë, or between the bone and dura mater. Suppuration in any of these three situations may be followed by necrosis of the bone, by septicæmia or pyæmia, or by inflammation of the brain and its membranes. When a flap of the scalp has been completely detached, and even when the pericranium has also been lost, necrosis need not necessarily occur, since granulations may spring up from the bone, and cicatrization follow.

Treatment.—The scalp should be shaved for some distance around the wound, well washed with soap and water, then with ether or turpentine, and finally with an antiseptic, whilst the wound should be carefully cleansed from all loose hairs, dirt, grit, &c., then flushed out with the antiseptic, and, if small and incised, closed with adhesive strapping over a pad of sal alembroth gauze and supported by a capeline or other form of bandage. When large portions of the scalp have been stripped up but not detached, the flaps after cleansing should be carefully replaced, and secured by aseptic sutures. Hæmorrhage is usually readily controlled by pressure, though occasionally it may be necessary to completely divide a partially torn artery or to apply a ligature. If the wound is extensive the scalp should be completely shaved and cleansed as above mentioned, whilst the patient should be kept at rest for a few days, placed on low diet, a smart purge given, and a careful watch made for signs of suppuration. Should such occur, the adhering margins of the wound should be separated to permit the free escape of the pus, and the wound be allowed to heal by granulations. If pus forms at some distance from the wound, an incision must be made at that spot through the scalp, of course avoiding the track of any large vessel.

Injuries of the Cranial Bones.

Contusions of the cranial bones are always serious, especially when attended with a wound of the scalp, inasmuch as they are liable to be followed by—1, Inflammation of the pericranium, which may terminate in suppuration between it and the bone, and necrosis of the external table or even of the whole thickness of the skull; 2, suppuration in the diploë, with implication of the large diploic veins, and probably septicæmia or pyæmia; 3, suppuration between the bone and dura mater, and subsequent general meningitis; 4, chronic inflammatory thickening of the cranial bones or dura mater, giving rise to constant headache, impairment of one of the special senses, epilepsy, or even insanity; and 5, cerebral abscess.

Signs.—Contusions of the skull are attended by no primary symptoms, but should any of the above-mentioned conditions supervene there will be the usual signs of inflammation localized to the injured spot, with more or less constitutional disturbance. 1. In simple pericranial inflammation the symptoms will usually subside in a few days. 2. Should pus form between the pericranium and the bone, there may be chills, and perhaps rigors, with local signs of suppuration; whilst the bone, should necrosis occur, will become dry and yellowish-brown or greenish-white in colour. 3. Should suppuration ensue in the diploë, there will be rigors, followed by high temperature, and probably, later, signs of pyæmia or septicæmia. 4. Pus between the bone and dura mater will be indicated by headache, vomiting, rigors, monoplegia or hemiplegia, delirium, or stupor, followed by convulsions or coma (see *intracranial suppuration*); whilst locally a circumscribed swelling may form over the injured part (*Pott's puffy tumour*), or if there be a wound it will become dry and the bone discoloured.

Treatment.—When, from the account of the injury, it is probable that the bone has been contused, measures should be taken to prevent inflammation by rest, cold to the head, free purging, and, where there is a wound, by strict antiseptic precautions. Should suppuration be suspected between the pericranium and the bone, free incisions to let out the pus should at once be made; whilst should the signs point to the formation of pus between the bone and dura mater, the trephine should be applied. For suppuration in the diploë, and the consequent septicæmia and pyæmia, little or nothing can be done.

FRACTURES OF THE BONES OF THE SKULL may be divided into—1, Fractures of the vault; and 2, Fractures of the base.

1. FRACTURES OF THE VAULT.—*Causes.*—Generally *direct* violence, as a blow on the head with a sharp-pointed body, or fall on a sharp edge. (Blows with soft bodies or falls on soft ground on the head more often cause a fracture of the base, or a fissured fracture extending over the vault to the base.) Occasionally *indirect* violence, as a blow, say, on the front of the head, causing a fracture at the back (*fracture by contrecoup*).

Varieties.—The fracture may take the form of a simple fissure (*fissured fracture*), or of several fissures radiating in various directions (*stellate or radiated fracture*); or the skull at the seat of injury may be broken into several pieces (*comminuted fracture*), one or more of which may be pressed inwards below the surface of the rest of the bone (*depressed fracture*); or a portion of bone in rare instances, as in some forms of sabre-wounds, may be raised above the surface of the skull (*elevated fracture*). At times the fracture consists of a mere puncture of the bone, with driving inwards into the membranes or brain of the sharp fragments of the inner table (*punctured fracture*); and lastly, the fracture may be limited either to the outer or to the inner table of the skull (*partial fracture*). In any of these varieties, except, perhaps, in the punctured, the scalp may remain whole, when the fracture, as in other situations, is said to be *simple*; or there may be a wound of the scalp leading to the fracture, when it is said to be *compound*. In children the bone may be depressed without fracture.

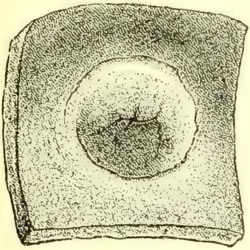


FIG. 112.—Depressed fracture (pond variety).
(St. Bartholomew's Hospital Museum.)

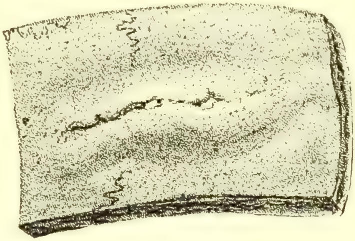


FIG. 113.—Elevated fracture, probably from the cut of a sabre.
(St. Bartholomew's Hospital Museum.)

State of the parts.—In *simple fissure* there is no displacement of the bone, but a mere crack extending from the part struck for a variable distance over the vault, and frequently running through the base of the skull. In the *stellate fracture* several fissures radiate over the vault from a central point, at which the bone is frequently punctured. The *comminuted fracture* is generally compound, and one or more of the fragments may be completely detached or driven through the dura mater into the brain, which itself may protrude through the external wound. In the *depressed fracture* the depressed fragments may be loose or firmly locked together, often forming a shallow or deep rounded or oval depression,—*pond and gutter* fractures, as they are sometimes called (Fig. 112). *Elevated fractures* (Fig. 113) are not often met with in civil practice. They are the result of oblique cuts, as by a sabre, and only occur in young adults whilst the bone is comparatively soft. In *punctured fractures* (Fig. 114), which are generally produced by a blow with a sharp instrument, as a pick-axe or a fragment of a falling chimney-pot, or by a fall on a spike, &c., the splinters of the internal table are often driven into the dura mater or brain at right angles to the rest of the bone. When the membranes are not injured at the time of the accident, the irritation of these sharp fragments, if not removed, is nearly certain to set up meningitis. At times the inflicting body has been found broken off flush with the surface of the skull. Fracture of the *external table* alone is most common over the frontal sinuses, where it is separated for some distance from the internal. In fracture of the *internal table* (Fig. 115), which is a rare accident, there may be merely a splintering of the bone, or a fragment may be completely detached or driven into the dura mater or brain. Any of these fractures may be complicated by laceration or other injury of the brain or its membranes, or by rupture of the middle meningeal artery or one of the venous sinuses. In all fractures involving both tables, except in the simple fissure, there is usually greater splintering of the internal than of the external table. In fractures, however, produced from within the cranium, as by a bullet passing through the skull, the external table at the aperture of exit is more splintered than the internal. The reason for the greater splintering of the internal table (or the external table when fractured from within) is, that the force is broken in perforating the external table, and becomes more distributed over the internal. It was formerly said to be due to the internal table being more brittle than the external.

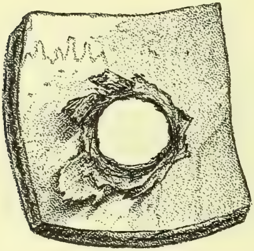


Fig. 114.—Punctured fracture. (St. Bartholomew's Hospital Museum.)

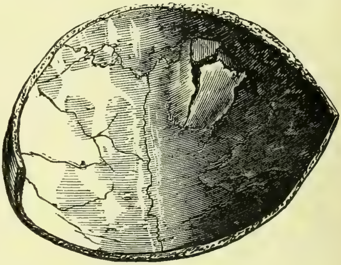


Fig. 115.—Fracture of the internal table. (Druitt's Surgery.)

Signs.—Whatever the form of fracture, it may be accompanied by signs of concussion, compression, or other injury of the brain.

Here only are given the principal local signs of the various forms of fracture of the vault. In a *simple fissured fracture* there is no sign, but in the *compound variety* the fissure may be detected by the finger in the wound. A sharp edge of the torn pericranium, a suture, or a natural inequality may, however, if care is not exercised, be mistaken for such a fissure. In the *depressed fracture* the depression in the bone in the *simple* variety may be obscured by extravasated blood either in the scalp or under the pericranium, but in the *compound* variety it can be felt by the finger and, if the wound is large, seen. In both varieties, when the bone is much depressed, signs of local compression of the brain may be present. In the *punctured fracture* the sharp fragments may be detected, with the finger or with a probe, projecting into the interior of the cranium, and signs of local compression may or may not be present; later, symptoms of inflammation of the brain, if the fragments are not removed, will almost certainly supervene. In both the compound depressed and punctured fracture there may be comminution or loss of bone, and portions of lacerated brain substance may at times exude through the fracture. *Fracture of the inner table* is very difficult to diagnose, but later it may be indicated by an increase of local temperature, signs of local compression, and localized pain from irritation of the dura mater. It is said that a friction sound may sometimes be heard, from the rubbing of the brain and pia mater on the sharp fragments. When a fracture is situated over the frontal sinuses there may be emphysema from escape of air into the connective tissue, or if the fracture is compound air may be forced out of the wound on blowing the nose.

The dangers of fracture of the vault may be summed up as—1. Immediate, (*a*) injury to the brain, and (*b*) septic inflammation; and 2. Remote, (*a*) continued headache, (*b*) epilepsy, and (*c*) insanity.

The *treatment* of fracture of the vault will necessarily vary according to the nature of the fracture and of any cerebral complications that may be present. The general indications are to prevent inflammation of the brain and its membranes, and to relieve any existing brain complication. Thus the patient should be placed at perfect rest in a darkened room, every source of cerebral irritation avoided, an ice-bag applied to the shaven head, the bowels acted on by a calomel purge, and the diet restricted to slops. When the fracture is compound, it should be fully exposed by a free incision in the scalp, and every care taken to render the wound aseptic, and to promote healing by the first intention. 1. In *fissured* fracture, great care should be taken to remove any dirt or hair from the fissure, widening it if necessary for this purpose by chiselling away one of its margins. When symptoms of cerebral compression are present the question of trephining will turn upon the probable nature of the cerebral lesion (see *Compression of*

Brain). 2. In *depressed* fracture the treatment will differ according as the fracture is simple or compound, and according as symptoms of local compression of the brain are or are not present. In the *simple* form, unless the depression is deep and there are signs of local compression, no operative interference should be undertaken. In the *compound* form, any fragment found loose or penetrating the membranes of the brain should be removed, or if slightly depressed, raised, provided the elevator can be readily inserted beneath it. If a fragment is deeply depressed and cannot be raised by the elevator the trephine had better be applied. When, however, the depression is but slight, and the fragments are interlocked, as in *pond* and *gutter* fractures, the case, unless there are signs of local compression of the brain, should, as a rule, be left to nature. The patient, however, should be carefully watched lest inflammation supervene, on the first signs of which the depressed bone should be removed by the aid of the trephine. In both the simple and compound varieties the depressed bone, if it is apparently causing compression of the brain, must be raised by the elevator or by means of the trephine.

Such perhaps has been the usual teaching, but there are many surgeons, and amongst them the author, who now recommend the raising of the depressed fragments under nearly all circumstances, even when there is no external wound; as although many cases of depressed fracture undoubtedly recover, nevertheless, inflammation of the brain and its membranes, or if this danger is escaped, subsequent trouble, such as long-continued headache, progressive mental inability, or even epilepsy and insanity, may ensue from the irritation of the depressed bone, or from the damage done by it to the dura or brain. In *punctured* fracture the trephine should always be applied, as here the fragments are driven vertically inwards (see Fig. 114), and though they may not have punctured the dura, will invariably set up inflammation if not removed. In fracture of the *internal table*, too, the trephine ought to be applied; but this form of fracture is seldom diagnosed.

After any kind of fracture the patient should be carefully watched for a month or six weeks, and even though no complications are present at first, the greatest care should be exercised, and any indiscretion in diet, abuse of stimulants, or undue mental excitement, should be avoided. On the first sign of intracranial mischief such as local paralysis, epilepsy or optic neuritis, the trephine should be used.

2. Fracture of the base is generally caused by a blow or fall upon the vault, the fissure extending from the part struck to the base; or it may be due to a fall upon the feet or nates, the fracture being then produced by the shock transmitted to the occipital bone through the spine. Rarely it has been caused by a sharp instrument, as a sword thrust through the roof of the orbit or nose, or by

a blow on the lower jaw fracturing the glenoid cavity or forcing the condyle through it. As a rule the anterior, middle or posterior fossa is found fractured, according as the blow falls upon the anterior, middle, or posterior part of the vault of the skull. Should the force, however, be very severe, fissures may radiate from the seat of injury to two, or even to all three fossæ. Fractures through the middle fossa generally involve the petrous portion of the temporal bone on one or both sides of the skull. Thus they frequently extend through the internal and external auditory meatus and walls of the tympanum, lacerating the prolongation of dura mater contained in the internal auditory meatus, the reflexion of the arachnoid around the seventh pair of nerves, and the membrana tympani, and so allow of the escape of the cerebro-spinal fluid from the external auditory meatus. The fracture may also involve the lateral sinus or middle meningeal artery, in which case blood may be found mixed with the cerebro-spinal fluid that escapes from the ear. Fracture of the posterior fossa extends through the foramen magnum of the occipital bone, and frequently through the petrous portions of the temporal bones. Fracture of the anterior fossa involves the roof of the orbit and nose. One or more of the nerves that escape through the bony foramina in the base of the skull, the lateral sinus, the middle meningeal artery, or one of the smaller blood-channels are frequently torn or otherwise injured in a fracture of the base; whilst the inferior lobes of the brain are often extensively lacerated and contused, or compressed by extravasated blood. It should be remembered that a fracture of the base, if the membrana tympani or the mucous membrane covering the cribriform plate of the ethmoid bone is ruptured, is really of the nature of a compound fracture, and hence is liable to be followed by septic inflammation, which, moreover, may spread to the membranes and brain.

Signs.—At times there may be none, and the nature of the injury may be quite overlooked. Generally, however, symptoms, such as compression, indicative of a severe lesion of the brain co-exist, and these, together with the history of the way in which the injury occurred, should lead us to suspect that the base is fractured. The signs, however, which when present may be considered diagnostic of the injury are—1. The escape of cerebro-spinal fluid from the ear, nose, or mouth, or from a wound if one exists. 2. The escape of blood from similar situations. 3. Effusion of blood under the conjunctiva, about the mastoid process, or in the sub-occipital region; and 4. Injury of one or more of the cranial nerves.

1. Cerebro-spinal fluid consists principally of water holding in solution a large amount of chloride of sodium. It has a low specific gravity (1002), and contains a substance which reduces

copper oxide but is not sugar, and little or no albumen. When it escapes in considerable quantities (several pints in the twenty-four hours) immediately after an injury, it is pathognomonic of fracture of the base. Escaping from the ear, it indicates fracture of the middle or posterior fossa; from the nose or mouth, generally the anterior fossa, though in fracture of the middle or posterior fossa it may, by passing along the Eustachian tube, or through a fracture of the basilar process with laceration of the mucous membrane of the pharyngeal vault, also come from the nose or mouth.

2. Blood may escape from the same parts and by the same channels but has not the like diagnostic value, since bleeding from the ear, and especially from the nose, may occur from causes other than fracture. Still when blood escapes in considerable quantities, and for some time after the injury, it is when combined with other evidence of severe cerebral mischief a sign of importance. It should not be forgotten that blood coming from the nose or roof of the pharynx may be swallowed and afterwards vomited or passed per rectum.

3. Effusion of blood under the ocular conjunctiva and ecchymosis about the mastoid process and sub-occipital region, are signs of less value; the former may indicate fracture of the anterior, and the latter fracture of the posterior fossa, the blood passing along the floor of the orbit in the one case to the conjunctiva, and in the other draining through the fracture and appearing under the skin.

4. Injury to one or more of the cranial nerves will be indicated by paralysis, loss of function, or spasm of the parts which they supply. Thus there may be dropping of the upper eyelid (*ptosis*), external squint, loss of accommodation, double vision (*diplopia*), and dilatation of the pupil, when the third nerve is affected; spasm or paralysis of the facial muscles (*Bell's paralysis*), deafness or loss of sight if the facial, auditory or optic is injured, &c., but as the patient is frequently comatose these signs may not afford much information. The paralysis when the facial nerve is affected may come on immediately after the accident or not for some days. In the latter case it is due to inflammatory effusion about the nerve as it passes through the aqueduct of Fallopius over the tympanum.

The *prognosis* is always grave, the lesion generally, though not invariably, terminating fatally from concomitant injury to the brain, or from septic inflammation of the brain and its membranes.

The *treatment* should be directed towards the prevention of inflammation of the brain, in the way described under fracture of the vault (p. 329). When the membrana tympani is ruptured, an attempt should be made to prevent septic inflammation, by syringing out the auditory meatus with carbolic or sublimate lotion, and applying an antiseptic dressing to the cleansed ear and shaven scalp around. To prevent infection by the Eustachian tube the nose and naso-pharynx may be well cleansed by antiseptic sprays, insufflated with iodoform or boric acid and the nose lightly packed with sublimate gauze. Should intracranial inflammation supervene, it must be treated in the way indicated under that head (p. 343).

Injuries of the Brain and its Membranes.

CONCUSSION OF THE BRAIN.—This term is applied to a collection of symptoms supposed to depend on a shaking or commotion of the brain substance. It is popularly spoken of as '*stunning*.'

Pathology.—The exact condition of the brain that gives rise to the symptoms which goes by the name of concussion is not known. By some it is believed that they depend on the mere shock to the brain—that there is some vibration or molecular disturbance of its particles, or anæmia of its substance induced by spasm of the small arteries, and that the shock may prove fatal in this way without any lesion being discovered after death. Generally, however, a slight contusion or laceration of the brain, or punctiform extravasations of blood in its substance have been found, and to such some attribute the symptoms of concussion. In the few cases that have been immediately fatal after a blow on the head without any obvious lesion having been discovered in the brain, the *post-mortem* examination has been unfortunately incomplete. Hence it is maintained by those who hold that there is always an obvious lesion, that death in these cases might have resulted from other mischief, such as fracture of the cervical spine.

Symptoms.—Concussion may be divided into two stages—1. Insensibility; 2. Reaction. 1. *The first stage* comes on immediately on the receipt of injury; it may be quite transitory, the patient merely losing consciousness for a few minutes, and then recovering completely; or it may last for a few hours or a few days or even longer. The patient lies in an unconscious condition, but can be roused momentarily on shaking him, or shouting in his ear. There is loss of all power of motion; the pulse is feeble, fluttering, often frequent; the respirations are shallow, and quiet or sighing; and the surface is cold, often clammy, the temperature sometimes being as low as 97 or 96. The pupils are variable, but sensitive to light. The sphincters are often relaxed at the time of injury, allowing the involuntary passage of fæces and urine, but are not paralysed. This condition, after lasting for a variable time, usually passes gradually into the second stage—that of reaction; or symptoms of compression or of inflammation of the brain may come on without the patient recovering consciousness. 2. *The second stage*, or that of *reaction*, is marked by a gradual return to consciousness, and is usually preceded by vomiting, which is therefore regarded as a favourable omen. The skin becomes warm, the pulse increased in frequency, and the temperature slightly raised. These symptoms commonly terminate in complete convalescence, or they may run into those of inflammation of the brain. At times, however, the patient may relapse into a state of unconsciousness and die, or he may pass into the condition known as 'cerebral irritation' and then recover, or certain impairments of brain function may remain.

The *remote effects* of concussion may be enumerated as headache, confusion of thought, mental irritability, impaired virility, optic neuritis and atrophy, epilepsy, or even insanity. These after-effects are more likely to occur if there is an inherited predisposition to nervous diseases, and appear to be brought on by excitement, abuse of stimulants, or excesses in diet. In some of these cases the brain has been examined after death, but no organic lesion has been found.

Treatment.—The chief indication is to restore the cerebral functions by promoting the cerebral circulation, taking care not to produce too violent a reaction. Thus the patient should be placed at perfect rest; warmth applied to the surface by means of blankets, hot bottles, and, if necessary, by friction; and small quantities of diffusible stimulants, as ammonia or warm tea, administered. Alcohol should not as a rule be given. When reaction has come on, inflammation must be warded off by gentle purgatives, low diet, and the avoidance of stimulants and of mental exertion.

COMPRESSION OF THE BRAIN after an injury may be caused by: 1. A fragment of depressed bone; 2. Extravasated blood; 3. Pus, or other inflammatory products; and 4. A foreign body, such as a bullet.

The *signs* of compression, *i.e.*, of pressure on the brain, vary according as the compression is made over a wide area or is localized to a particular part. Thus, when the pressure is *diffused* over a considerable portion of the brain, the patient lies in a completely unconscious state, and cannot be roused either by shouting in his ear or by shaking him. The extremities on one or both sides are paralysed; the face is livid, at times flushed; the temperature is usually low, but at times raised; the pulse is full and slow, often not beating more than 40 to the minute, but it becomes quick, weak and irregular as the compression increases, and the cardio-inhibitory centres in the medulla get exhausted; the respiration is slow, laboured, and stertorous, *i.e.*, a peculiar noise is made during expiration by the flapping of the paralysed soft palate, but like the pulse it becomes rapid as the compression becomes deeper; the cheeks and lips puff out at each expiration in consequence of paralysis of the buccinator and muscles of the lips; the pupils are fixed (*i.e.*, the iris does not respond to light), and may be either dilated or contracted, or one may be dilated and the other contracted ; the urine is at first retained owing to the paralysis of the muscular coat of the bladder, but afterwards dribbles away as the bladder becomes over-distended and will hold no more ; the fæces pass involuntarily in consequence of paralysis of the sphincters ; at times there are violent convulsions. When on the other hand the pressure is *localized* the coma is usually less profound, the pupil on one side only may be fixed and the paralysis may be limited to one side, possibly to an arm or leg, or to one side of the face, or there may be convulsive twitching of certain muscles or of a limb. The compression-symptoms may gradually deepen till the patient dies ; or he may recover on the removal of the cause, *e.g.*, a piece of bone or a clot of blood.

The *diagnosis of the cause of the compression* will rest on the fact that when due to bone or blood the symptoms come on within twenty-four hours of the injury, generally directly if due to bone, or after a brief interval of consciousness if due to blood ; but not till three or four days after the injury if due to the pressure of inflammatory exudation or of pus, in which case, moreover, they are preceded by signs of inflammation. Where the signs are general, as given above, the injury usually depends upon the pressure of extravasated blood on some of the central portions of the brain following upon laceration of the brain-substance, or upon general inflammation of the brain or its membranes. But when the signs are those of local pressure on the surface of the brain, the lesion will probably be due to a depressed portion of bone or a circumscribed extravasation of blood between the bone and dura, or a collection of pus either between the bone and dura or in the cortical substance of the brain.

The conditions that may simulate compression of the brain are (1) Intoxication ; (2) Opium poisoning ; (3) Apoplexy ; and (4) Uræmia. The presence of paralysis in compression and apoplexy, its absence in opium poisoning, intoxication and uræmia ; the condition of the pupils—dilated and fixed in compression, contracted unless the patient is roused in intoxication, contracted to pin points in opium poisoning ; and the presence of œdema of the legs and of albumen in the urine in uræmia are points of some service. The diagnosis of these conditions, however, is often attended with great difficulty. Thus the head injury may be the result of a fall due to a fit of apoplexy, or the head injury or apoplexy may occur whilst the patient is drunk, or again the apoplexy and resulting head injury may be caused by uræmia. In all cases of doubt, therefore, it is better to treat the case as if a serious head lesion had occurred than to condemn a patient with apoplexy or fracture of the base of the skull to die in a police cell on the assumption that he is only drunk.

The *treatment* will necessarily depend upon the cause of the compression. Thus a depressed fragment of bone should be removed (see *depressed fracture*), a clot between the bone and dura let out by the trephine, and a circumscribed collection of pus between the bone and dura, or in the membranes or brain, also evacuated by the trephine. But when the depression depends upon extravasated blood in the subdural or subarachnoid space or substance of the brain, or upon a general inflammation of the brain and its membranes, no surgical procedure is of any avail. In any case, therefore, the first point to consider in regard to treatment is whether the compression of the brain is due to a removable cause, or to one that is beyond the reach of surgery.

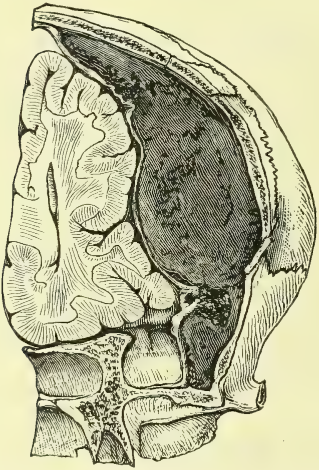


Fig. 116.—Subcranial hæmorrhage, the result of a depressed fracture. (St. Bartholomew's Hospital Museum. No. 881 *b*.)

Extravasation of blood in the cranium may occur—1. Between the bone and dura; 2. In the subdural space; 3. In the subarachnoid space; and 4. In the substance of the brain.

1. *Blood between the bone and dura* (*subcranial extravasation*) is generally due to rupture of the middle meningeal artery, especially its anterior branch, and is commonly associated with a fissured fracture extending across the line of the artery. At times it is due to a wound of the lateral sinus or a laceration of some of the small vessels which run from the dura into the bone. The blood is usually extravasated in large quantities, widely separating the dura from the bone, and producing severe compression of the brain (Fig. 116). Should the patient survive, the blood may become organized or absorbed.

2. *Subdural extravasation* is due to rupture of capillary vessels, and is very common in severe head injuries. The blood usually extends widely over the surface of the arachnoid, and, if the patient survive, may become absorbed or organized, forming a false membrane, and in some cases a blood-cyst.

3. *Subarachnoid extravasation* is generally associated with contusion or laceration of the brain and may depend upon rupture of the middle cerebral artery. The blood may spread widely, and the patient die of compression, or it may in some cases become absorbed, but it does not as a rule become organized.

4. *Blood in the brain substance* (*intracerebral extravasation*) is the result of contusion or laceration of the brain, with rupture of the small vessels. When the laceration is extensive, it is usually fatal; but should the patient survive, the blood may undergo changes similar to those of an ordinary apoplectic clot, or may break down into pus (*cerebral abscess*).

The *symptoms* of intracranial extravasation are those of compression of the brain, but vary according to the situation of the blood and the rapidity with which it is extravasated. The diagnosis may be more or less obscured by the presence of concomitant injury to the brain. 1. When the *blood is between the bone and dura* the patient, to take a typical case, is concussed at the time of the injury, recovers from the concussion, and is, perhaps, rational; then as the action of the heart becomes more forcible and blood is poured out from the wounded vessel, he grows faint and sinks into a state of coma. The coma gradually deepens, and he usually dies in from a few hours to a few days after the injury with signs of profound compression of the brain. The paralysis at first is on the side opposite to the injury, and only a limited area of the cortex may be affected, as the face or arm centre, but it may become general as the blood extends over the surface of the brain. The pupil on the *same side* as the injury may at first react to light, but becomes dilated and fixed as the blood extends to the base and presses on the third nerve. At times the eyeball may protrude owing to the pressure upon the cavernous sinus. Very occasionally reflex convulsions, also on the side of the injury, may be set up by irritation of the nerves of the dura. A higher surface-temperature may occasionally be detected on the side opposite to that of the injury. If a fissured fracture is present, there may be some fulness externally from the escape of blood through the fissure. 2. When the *blood is in the subdural space*, the signs of compression usually come on rapidly, and without any rational interval; but there are no special symptoms by which it can be diagnosed, or, indeed, at times, distinguished from blood between the bone and dura. 3. When the *blood is beneath the arachnoid* in quantities sufficient to cause compression, it will probably be associated with severe laceration of the brain, and the patient will not, as a rule, regain consciousness (see *Laceration of Brain*). 4. When the *blood is in the brain substance* it produces symptoms which cannot be distinguished from those of apoplexy, except perhaps by the history of the injury, and not always then, as it may be impossible to determine whether the patient first fell and thus injured his brain, causing effusion of the blood into its substance, or whether a vessel first gave way, and the fall was the consequence of the escape of blood into the brain. In attempting to make out the situation of the hæmorrhage, some help may be obtained by *puncture* of the subarachnoid space in the *lumbar* region. Thus, if the cerebro-spinal fluid drawn off is clear, the blood is probably between the bone and dura; if it is blood-stained, the blood is probably in the subdural space; whilst if it contains much blood, the extravasation is probably beneath the arachnoid and in the brain substance, and points to severe laceration of the brain.

Treatment.—When it is clear that the hæmorrhage is from the middle meningeal artery, and it appears probable that no other serious injury of the brain has been received, the trephine should be applied for the purpose of removing the clot and securing the bleeding vessel. The situation of the anterior branch of the artery, the one which is nearly always torn, is about an inch and a half behind the external angular process of the orbit (Fig. 117, A), and over this spot a crown of bone should be removed. If clot now protrudes at the opening, it should be turned out by some form of scoop, and if the bleeding artery is then seen, an attempt should be made to tie or twist it, or to compress it by plugging the groove in the bone in which it lies with a piece of aseptic wax or wood. If the bleeding point cannot be reached, more bone may be cut away. If, however, on the removal of the clot, the brain does not expand, and the hæmorrhage is so profuse that the wounded artery cannot be seen, the external or common carotid artery may be compressed or tied, and ice applied to the side of the head. If no clot is found a second crown of bone may be removed further back in the same horizontal line, just below the parietal eminence, *i.e.*, in the course of the posterior branch of the middle meningeal (Fig. 117, B). If the blood comes from a large sinus, pressure or a lateral ligature may be applied or

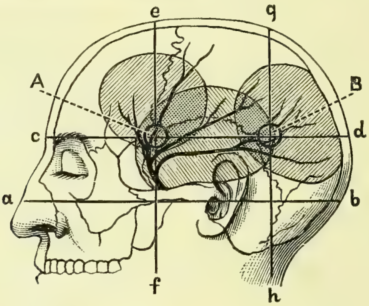


Fig. 117.—The positions for trephining to expose the A. anterior, and B. posterior branch of the middle meningeal artery. *a b*, horizontal line through meatus; *c d*, horizontal line on level with eyebrow; *e f*, vertical line $1\frac{1}{2}$ inch behind external angular process; *g h*, vertical line at posterior border of mastoid process. Where these lines intersect at A and B the trephine is applied. The shading shows common situation of the clots. (Keen.)

the whole sinus tied. When no blood is found between the bone and dura, but the dura itself is bluish in colour, does not pulsate with the brain, and bulges into the trephine hole, indicating the presence of blood beneath it, an incision should be made through it and the blood let out. The anterior trephine wound may then be enlarged upwards and backwards, so as to expose the Sylvian fissure and middle cerebral artery, which should be tied if found wounded. Great care must subsequently be taken to keep the wound aseptic. For hæmorrhage in the substance of the brain surgical interference is not permissible; all that can be done is to treat the case as one of ordinary apoplexy from cerebral hæmorrhage, *i.e.*, by free purging, cold to the head, hot bottles to the feet, &c.

CONTUSION OR BRUISING OF THE BRAIN may be due to any severe violence, and may occur with or without injury of the scalp or cranial bones. It is often accompanied by laceration of the brain substance and of the pia mater and arachnoid. The bruising may be general or circumscribed. In the latter case it may occur immediately beneath that part of the cranium to which the violence was applied, or on the opposite part of the brain, the brain being as it were dashed by the violence of the blow against the cranial wall furthest from the part of the skull to which the force was applied. Like bruises of other soft tissues, it is attended by extravasation of blood from rupture of the smaller vessels. It may terminate in absorption of the blood and healing of the bruised parts, or in general inflammation of the brain and its membranes, or in local inflammation and in cerebral abscess. The *symptoms* are generally obscured by those of concussion or compression, and it is seldom that an accurate diagnosis can be made. Irritability, restlessness, and spasms of certain muscles when a motor centre is injured, are said, however, to point to contusion. The chief indication for *treatment* is to prevent the occurrence of inflammation of the brain (see p. 329).

LACERATION OF THE BRAIN may occur with or without fracture or other injury of the skull. The laceration is most common in the anterior part of the frontal and in the temporo-sphenoidal lobe, owing in part to the unevenness of the base of the skull on which these lobes rest, and in part to the fact that the back and the top of the head are most exposed to injury, the brain, as in contusion, being generally lacerated on the side of the head directly opposite to that on which the force is received. At times, however, the brain is lacerated directly beneath that part of the skull to which the force is applied. Laceration may also be caused by a fragment of a bone, as in depressed or punctured fracture, or by the passage of a bullet or the thrust of a sword through the orbit or nose.

Pathology.—The laceration may be slight or very extensive, and is generally accompanied by more or less bruising of the surrounding brain-tissue and extravasation of blood over its surface. The pia mater is also lacerated, and where the injury is produced by a fragment of bone the dura is likewise torn, and in some cases, large portions of the lacerated brain may protrude through the skull. Inflammation of the brain and its membranes is liable to follow, and to assume a septic character, and spread widely if there is an external wound which has not been kept aseptic. Should the patient recover, cicatrization, with adhesion of the membranes, occurs, the extravasated blood in the meantime undergoing the changes already described.

The *symptoms* vary. At times there may be none, although a considerable mass of brain tissue is protruding through a fracture in the skull. Or they may be obscured by signs of concussion, or, if much blood has been extravasated, by those of compression. There are no signs pathognomonic of laceration of the brain, but convulsions, localized spasms or paralysis, long-continued insensibility without coma, and the collection of symptoms known as cerebral irritation, point to such an injury. The symptoms of *cerebral irritation* may be described as follows:—The patient lies in a torpid or semi-conscious condition, coiled up on one side, with his limbs in a general state of flexion. If spoken to, he evinces great irritability of temper, answering momentarily and sharply, perhaps shaking himself, and then relapses into his torpid state. His pupils are contracted, his eyes closed, but his pulse, temperature, and respirations are normal. *Is there any way of localizing the seat of the laceration where no external injury exists?* "If a patient receive a blow upon the head, and it is found that localized paralysis is present, we conclude that there exists a laceration of some severity in the cortical centre corresponding to the muscles implicated. If almost immediately after the injury there is a distinct spasm affecting a localized group of muscles—a monospasm—we conclude that hæmorrhage is going on from the lacerated brain substance, or breaking down the tissue of the centre corresponding to the affected muscles. If the monospasm extends, first affecting one side of the body, and finally both sides, so that the attacks assume the form of true epileptic fits, it is probable the extravasated blood is extending over the surface of the brain and irritating more or less widely the whole motor area" (*Erichsen*). Should there be motor aphasia, a lesion of the posterior extremity of the third left frontal convolution (*Broca's convolution*) is indicated (Fig. 118, B). Should there be facial spasm or paralysis, a lesion of the lower third of the ascending frontal and the contiguous part of the posterior end of the second frontal convolution is probably present (Fig. 118, F^4, F^2). Should there be paralysis of the arm—a brachial monoplegia—the middle portion of the ascending frontal and the contiguous part of the ascending parietal on the other side of the fissure of Rolando are probably affected, the upper part of this area representing the shoulder, the middle the elbow, and the lower the hand centre (Fig. 118, R^1 and P^1). Should there be paralysis of the lower limb, the lesion probably involves the upper end of the ascending parietal and the superior parietal lobule lying behind it, as far as the margin of the longitudinal fissure (Fig. 118, P^1 and P^2).

Briefly, therefore, a cortical lesion may be distinguished from a central, as follows:—In the *cortical lesion* the paralysis, although it may occur immediately after the accident, often does not appear for some time. It is incomplete and localized, and probably affects only one limb or a single group of muscles. In the *central lesion*, on the other hand, the paralysis occurs immediately after the injury; it is more complete and extensive, and the whole of one side, at least, will probably be paralysed.

In *bullet wounds* the missile may be detected by the aluminium gravity probe, which will follow in the track of the bullet by its own weight, but being light, will not make a false passage, or it may be detected by the "telephone probe," *i.e.*, a probe attached to a telephone receiver. If the bullet is struck a grating sensation is heard.

The *treatment* should be directed to the prevention of inflammation in the way already described. If there is a wound, with protrusion of the brain, the contused and protruded portions and any fragments pressing upon or penetrating the brain substance should be removed, hæmorrhage arrested, the wound cleansed with antiseptics, the dura sutured if practicable, a drain inserted, and the scalp replaced and sutured. In the case of a gunshot wound the bullet should be removed if possible, a counter trephine opening being made if necessary. The wound should be then rendered as aseptic as possible and drained, the tube being passed quite through the brain if a counter opening has been made. Where there is no wound, but signs of local irritation or of compression of the cortical motor area from blood-extravasation, the indications are to trephine. The guide to the spot for perforation is the line of the fissure of Rolando on the side opposite to that of the localized spasm or paralysis. This line may be found in various ways. (1) M. Lucas-Championnière (see Fig. 119) first finds the bregma, *i.e.*, the spot where the coronal joins the sagittal suture, by carrying a line directly over the vertex from one external auditory meatus to the other. The upper end of the Rolandic fissure is situated about two inches behind the bregma. The lower end of the fissure corresponds to a spot $2\frac{3}{4}$ inches behind the external angular process and about one inch above it. (2) Chiene folds a square of paper (Fig. 119) diagonally so as to bisect the rectangle at A formed by two of its sides into two angles of 45°; folds the paper again so as to bisect one of the angles of 45° into two angles of $22\frac{1}{2}°$. The sum of the angle of 45° and of one of the angles of $22\frac{1}{2}$° gives an angle of $67\frac{1}{2}$°, B A C, which represents sufficiently nearly the angle made

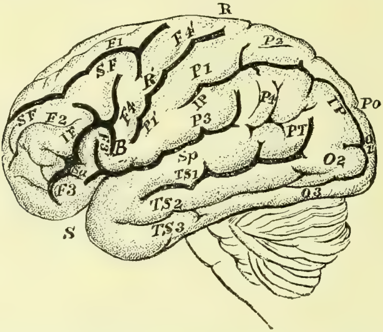


Fig. 118.—The cerebral convolutions; R, fissure of Rolando; F^4, ascending frontal convolution; P^1, ascending parietal convolution; F^1, F^2, F^3, superior, middle, and inferior frontal convolutions; S F, superior frontal sulcus; I F, inferior frontal sulcus; S, fissure of Sylvius; S$_a$, anterior limb of fissure of Sylvius; S^p, posterior limb of fissure of Sylvius; P^2, superior parietal convolution; P^3, supra-marginal convolution; P^4, angular convolution; I P, inter-parietal fissure; T S^1, T S^2, T S^3, superior, middle, and inferior temporo-sphenoidal convolutions; B, Broca's convolution; P$_o$, parieto-occipital fissure; O^1, O^2, O^3, superior, middle, and inferior occipital convolutions.

(After Lucas-Championnière and Erichsen.)

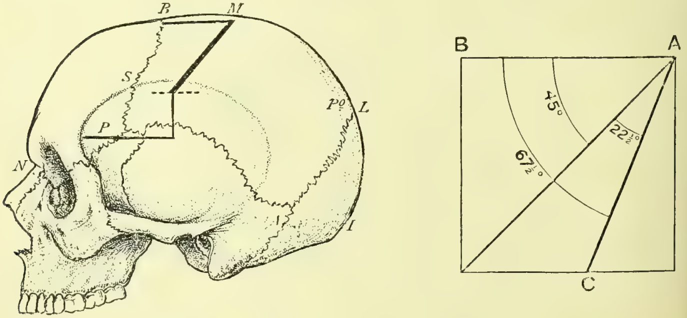


Fig. 119.—The situation of the line of Rolando. A, asterion; B, bregma; L, lambda; M, mid-point between N, nasion, and I, inion; P, pterion; S, stephanion; O P, occipto-parietal fissure.

by the fissure of Rolando with the sagittal suture, namely, 67°. The straight edge, A B, of the paper is then laid along the sagittal suture, the point A being applied half-an-inch behind a point midway between the nasion and inion, *i.e.*, to the top of the fissure of Rolando. The fissure runs for $3\frac{3}{8}$ inches along the line A C. We have already seen that the cortical motor centres are grouped around the Rolandic fissure. If therefore there is general hemiplegia, the perforation should be made over the middle of the line; if paralysis of the arm and leg, over the upper part of the line; if paralysis of the arm only, in front of the middle third of the line; if aphasia, below and a little in front of the line on the left side of the head; if there is paralysis of the leg alone, behind the upper third of the line; if paralysis of the arm and face, in front of the lower third of the line; if paralysis of the arm and aphasia, or paralysis of the face and aphasia, below and in front of the line.

INTRACRANIAL INFLAMMATION, though at times it may remain localized either to the membranes (*meningitis*) or to the brain (*encephalitis*), more often, in whatever way it begins, spreads from the one to the other (*meningo-encephalitis*).

Cause.—Wounds of the scalp; contusions or fractures of the bone; concussion, contusions, lacerations, and penetrating wounds of the brain.

Pathology.—It may be acute or chronic: septic and diffuse, or simple and circumscribed. *Acute inflammation* may begin in the dura, and remain confined to that membrane (*pachymeningitis*) or spread inwards to the other membranes and the brain; or it may begin in the brain, but then seldom spreads further outwards than the pia (*leptomeningitis*). When it begins in the bone or in the dura it is at first circumscribed, the inflammatory products, and, should suppuration occur, the pus, being confined between the bone and dura. Later, the inflammation may spread to the arachnoid, and thence to the pia and surface of the brain, diffusing itself widely through the subdural space and over the cerebral cortex. When it begins in the brain it is generally the result of a contusion or laceration of the cerebral substance, and may remain circumscribed, and eventually end in a cerebral abscess, or spread to the pia and then become diffuse. It seldom, however, involves the free surface of the arachnoid. The *post-mortem* appearances commonly observed are increased vascularity of the brain and its membranes, an exudation of greenish-yellow lymph, and distension of the ventricles with a serous blood-stained fluid; whilst the grey-matter is of a reddish hue, soft and diffluent, and the white more abundantly dotted over with "puncta vasculosa" than natural. In the *chronic form*, which is generally due to inflammation, caries or necrosis of the bone, or more rarely to a brain-injury, the dura becomes thickened and adherent to the bone, the arachnoid thickened, and the pia opaque and indurated, so that when removed its prolongations, which dip between the convolutions, can be pulled out without tearing.

The *symptoms* vary according as the inflammation is acute or chronic, diffuse or circumscribed; according as it begins in the dura or in the brain and pia; and according as it involves the vertex or base of the brain. The *general symptoms* in acute cases are, in the early stages, fever, pain in the head, generally on the same side as the wound if one is present, intolerance of light and sound, retching with probably a clean tongue, a quick, full pulse, flushed face, contracted pupils, violent beating of the carotids, restlessness, sleeplessness, and at times violent delirium. Later the symptoms pass into those of compression, the pupils becoming dilated and fixed, the pulse slow, and the breathing stertorous. Then follow paralysis, stupor, coma and death. Rigors will probably occur should pus form. In the *chronic form* of inflammation the symptoms are similar to those of the acute, but of less severity, and are later, as a rule, in making their appearance. Complete recovery may have apparently taken place, or there may have been headache or irritability of temper previous to the symptoms setting in. *Is there any way of localizing the inflammation?* 1. If ten to twenty days have elapsed since the injury; if the onset of the symptoms is sudden, though preceded perhaps by some headache; if there is a puffy swelling over the seat of injury, due to the separation of the pericranium from the bone by serous effusion; if the bone, should it be exposed, looks dry, white, and discoloured, or the wound unhealthy; and if the paralysis is localized,—the inflammation is probably between the bone and dura, and if a rigor has occurred, pus has probably formed. 2. If, on the other hand, there is no apparent injury of the scalp or bone; if the patient has had concussion; and if the symptoms set in a few hours after the injury,—the inflammation is probably in the brain or pia, where it has arisen in consequence of increased vascularity following the concussion. Or if the symptoms come on about the fourth or fifth day after the injury, when it had apparently been recovered from, the inflammation will probably be also in the brain or pia, but in this case due to contusion or laceration of the brain. 3. If, again, the symptoms are delayed some weeks, if there is optic neuritis or symptoms of disturbance of one or more of the motor areas, the inflammation is probably localized to some portion of the brain, and if a rigor has occurred, a cerebral abscess has probably formed.

The *treatment* may be divided into the preventive and the curative. The former consists briefly in guarding against the occurrence of septic changes in the wound if one is present, and in preventing congestion of the brain and its membranes by the means already indicated (see p. 329). The first signs of inflammation should be actively combated by a calomel purge, leeches to the temples and an ice-bag to the head; whilst pain should be subdued and sleep promoted by the cautious use of opium. The curative treatment consists in evacuating the products of the inflammation, should such, in spite of the preventive treatment, ensue. Thus, if there are signs of local suppuration between the bone and dura, the trephine should be applied over the seat of injury, or if one is not apparent, over the motor area at the spot indicated by localized paralysis or spasm. If, on removing the bone, the dura is seen to bulge, and the pulsations of the brain cannot be felt, the dura should be perforated, and if pus is still undiscovered, but the signs of suppuration are well marked, a fine trocar and cannula should be cautiously passed into the brain-substance. If there are signs of cerebral abscess, a trephine should be applied over the suspected spot, the dura incised, the brain carefully punctured, and if pus is discovered, a free incision made to let it out. If the inflammation and suppuration appears to be general rather than local, no operative treatment is usually advised, but it is a question whether timely removal of serum or pus by means of the trephine would not give better results than the ordinary expectant plan.

HERNIA CEREBRI is a protrusion of brain-substance through a hole in the cranium and dura. *Cause.*—It appears to be due to a localized swelling of the brain, consequent upon a general increase of intracranial pressure, and may occur after any injury of the cranium where there is loss of bone and a wound or sloughing of the dura, with bruising or laceration of the brain, or after an operation where brain-substance has been removed. *Pathology.*—The protrusion consists of brain-substance infiltrated with inflammatory products and blood, and is the result of the inflammatory swelling finding a vent in the only possible way in which it can escape, viz., through the hole in the cranium. The effused blood is due to the rupture of the obstructed capillaries, consequent upon the protruding mass becoming constricted by the margins of the aperture through which it is protruding. At times, when the rupture of the capillaries is extensive, the tumour consists almost entirely of clotted blood. *Signs.*—The hernia appears as a reddish-brown, blood-stained, fungus-looking mass, overhanging the hole in the cranium, through which it has protruded, and often pulsating synchronously with the brain. Should the inflammation subside, the protrusion will gradually recede, and the patient recover; but should it continue, the hernia will increase in size, and as more and more of the brain is involved, the patient sinks into a comatose state and dies. At times the protrusion may become constricted at its base, and slough away and the parts cicatrize; or an abscess may form in its interior and in the contiguous part of the brain, and death result from cerebral compression. The *treatment* consists in attempting to allay the inflammation of the brain, which is the cause of the hernia, by the means already described in Intracranial Inflammation. Formerly, pressure on the protrusion, shaving it off, and applying caustics, were the means employed, but they were not attended with success, and are now discarded as unscientific. Pressure would rather tend to cause an abscess or promote inflammation by keeping up tension. The hernia itself should be left alone, except when the inflammation has become chronic, when well-regulated pressure may possibly promote the absorption of inflammatory products and the shrinking and recession of the mass. Keen suggests that when there is loss of dura a flap of pericranium should be detached from the scalp and sutured with its osteogenetic surface uppermost to the dura. Others have succeeded in closing the gap in the bone by transplanting a flap of scalp with the underlying external table, whilst others have employed celluloid plates, &c.

Trephining the skull is indicated:—1. In all cases of punctured fracture. 2. In depressed fracture with symptoms of compression, whether simple or compound. 3. In localized extravasations of blood between the bone and dura. 4. In intracranial suppuration when the pus is circumscribed and situated between the bone and dura, in the subdural or subarachnoid space, or in the substance of the brain. 5. For the removal of a bullet lodged in an accessible situation in the brain. 6. In fracture of the inner table. 7. In epilepsy, mania, and continued headache following on head-injury. 8. For the removal of a cerebral tumour. 9. In microcephaly with idiocy. 10. In compound depressed fracture without symptoms, in which the fragments cannot be raised by the elevator, opinions differ as to the propriety of trephining. If the depression is considerable, I think it ought to be done, as should the patient escape the immediate danger of intracranial inflammation, he is liable to certain remote effects from the irritation of the depressed fragments, such as headache, epilepsy, mania, &c. (*see Depressed Fracture*, p. 330). *The operation.*—It need hardly be said that the strictest antiseptic precautions should be used throughout. Thus, the *whole scalp* should be shaved, and washed with soap and hot water, then with ether, turpentine, or ammonia, to remove all grease, and afterwards with perchloride of mercury or other antiseptic. If a wound of the scalp exists, it may be enlarged, otherwise a large semi-circular flap of the scalp, including the pericranium, should be turned down, so that when it is replaced after the operation the trephine hole is completely covered. The situation of the Rolandic fissure should be marked by an aniline pencil on the scalp, and its upper and lower ends and the point for the pin of the trephine further indicated on the vault by indenting the bone through the flap, so that the line of the fissure may be recognized when the flap is turned back. The trephine, with the pin protruded one-tenth of an inch, should be applied, and steadily worked, clearing the teeth from time to time with an aseptic sponge or brush. A good groove having been formed in the bone, the pin should be withdrawn. When the diploë is reached, which may be known by the bone-dust being soft and red, greater caution must be used, and a quill or probe introduced into the groove at intervals to ascertain whether perforation has taken place at any situation. When the crown of bone is loose it should be removed with the sequestrum forceps, and if it is intended to replace it, it should be kept warm in some weak antiseptic solution, and, at the end of the operation, cut into small pieces and placed in the hole, and the flap laid down over it. I have treated several cases in this way. The wounds healed by the first intention, and the integrity of the cranium was completely restored. If more room is necessary the trephine hole may be enlarged by Keen's rongeur forceps (Fig. 120), or by the surgical engine, the dura having been previously detached by the dural separator. If the dura has to be opened it should be incised parallel to the trephine hole and a quarter of an inch from its margin, great care being taken not to injure the cerebral vessels. If a vessel of the dura is injured it may be secured by passing a stitch under it through the dura with a curved needle. If a sinus is wounded pressure will, as a rule, suffice. The dura should be sutured by catgut and the wound closed, except perhaps at its lowest part, which may be left open for drainage. An antiseptic dressing should now be applied and secured with a head-cap, and over it an ice-bag to prevent inflammation. The trephine should not be applied, as a rule, over a suture, an air or a venous sinus, or over the middle meningeal artery, unless the operation is undertaken with a view to secure that vessel. The conical trephine, shown in Fig. 121, will be found a safer instrument than that in ordinary use, as with it the dura mater is less likely to be injured, and the handle also is more comfortable to work with. It can now be had with a metal handle and the improved button pin. Before trephining for the removal of a

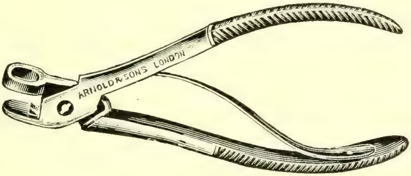


FIG. 120.—Keen's Rongeur forceps.

cerebral tumour morphia should be given, as it causes contraction of the small blood-vessels, and so has a tendency to lessen hæmorrhage. The anæsthetic, however, especially if chloroform is chosen, should be given in much smaller quantities when the patient is under the influence of morphia. Some surgeons now, instead of trephining, turn back a flap of scalp and bone by incising the scalp and chiselling through the bone except at one spot where it is fractured and turned up with the soft parts. At the end of the operation the osteo-scalp flap is replaced and fixed *in situ* by sutures. A very large area of the brain can be exposed in this way.

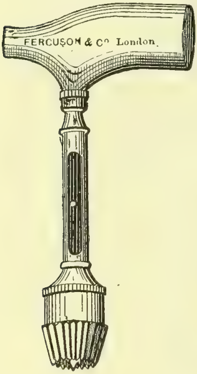


Fig. 121. — Conical trephine, with the author's improved handle.

INJURIES OF THE FACE.

Contusions of the face are very common. Amongst them may be mentioned "black-eye," which is attended with extravasation of blood in the loose cellular tissue of the eyelids. The swelling is often very great, the eye being completely closed, but it usually subsides in a few days. Suppuration occasionally occurs, a small incision then becoming necessary.

Wounds of the face, owing to the great vascularity of the parts, readily and rapidly heal. The edges of the wound should be approximated as accurately as possible, especially when near the eyelids, where there is danger of contraction, and united with horse-hair sutures. If quite superficial the wound may then be sealed with collodion; but if deep the surfaces should be supported by hare-lip pins or wire sutures, which, however, to prevent scarring, should be removed at the end of thirty-six hours. Wounds attended by loss of substance may subsequently require a plastic operation.

Foreign bodies in the nose.—Peas, beads, pebbles, and the like are sometimes pushed up the nose by children, where they sooner or later give rise to irritation and a muco-purulent and fœtid discharge. Indeed the presence of such a discharge from one nostril in a child should always lead the surgeon to make a careful search, if necessary under an anæsthetic, for a foreign body. The collar-stud and portion of lace trimming, shown in Fig. 122, I removed from the nose of a boy aged eight years. He had introduced them five years previously, and they had remained undetected till I saw him, the discharge having been looked upon as catarrhal. If allowed to remain, foreign bodies may cause ulceration, or even bone-disease. They can generally be removed by forceps, curettes, or the nasal douche, but before these are used the patient should close the opposite nostril and forcibly expire, since the body may often be expelled in this simple way. At times they have to be pushed back into the pharynx. Milder means failing, Rouge's operation (see *Diseases of Nose*) may become necessary. It should not be forgotten that foreign bodies occasionally enter the nose from behind during vomiting.

Foreign bodies in the ear.—In dealing with these it should be borne in mind that the middle is the narrowest part of the meatus, and that they may be readily pushed beyond this, so rendering their extraction extremely difficult. They should be removed by syringing with tepid water, and no attempt made to extract them with instruments unless their nature is such that the warmth and moisture of the part may cause them to swell, as is the case with peas. Under these circumstances, some of the various aural curettes, snares, &c., devised for the purpose may be used, but with great gentleness and aided by artificial light, the child, if unruly, being placed under an anæsthetic. If a rounded body, as a bead, which is incapable of swelling, does not come away on syringing, it should be left alone for the time, as it will subsequently, by setting up slight suppuration, become loosened, and can then be removed by again using the syringe. The incautious use of instruments has been attended by perforation of the membrana tympani, and even followed by fatal intracranial inflammation. As a caution it may be mentioned that the handle of the malleus has ere now been mistaken for a foreign body and roughly torn out.

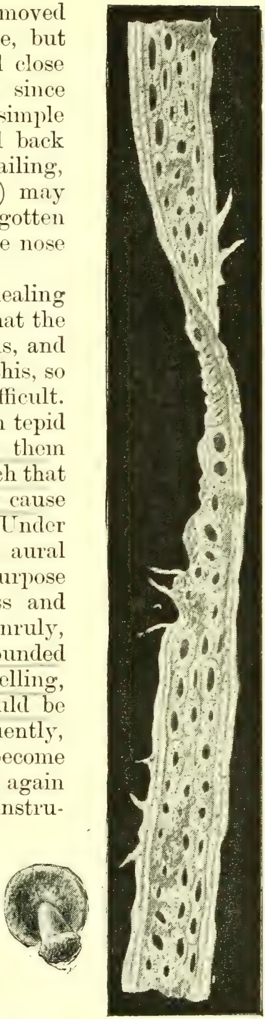


Fig. 122.—Collar stud and lace trimming (exact size) removed from the nose. (St. Bartholomew's Hospital Museum.)

Salivary fistula occasionally results from a wound of Stenson's duct. It is known by a small fistulous opening on the cheek from which saliva dribbles, especially when food is being taken. *Treatment.*—Numerous operations have been proposed and practised for this somewhat troublesome condition. The principle underlying them all is, first to establish a free opening of the duct into the mouth, and then, if the external opening does not heal, to close it by a plastic operation.

FRACTURE OF THE NASAL BONES is always the result of severe direct violence. The fracture is commonly transverse in direction, and is often comminuted and accompanied by much displacement and at times by emphysema. Occasionally the fracture extends through the perpendicular plate of the ethmoid and thence to the cribriform plate. Hence it may be complicated by subsequent inflammation of the brain and its membranes. *Treatment.*—The bones should be manipulated into position by the fingers externally and by a director passed up the nostril, or by the dressing forceps with one blade within and one blade outside the nose. The fragments should then be retained in position, which is often difficult, by pads of lint and strapping, or if such are insufficient, by some form of nose truss such as the author's. (See *Diseases of Nose.*) They unite very quickly by bony callus. The septum, where this has been deflected, should be straightened, so as to support the depressed bones, and kept in place by ivory plugs passed up the nostrils, or by other suitable retentive apparatus. Where the fracture has not been properly reduced much deformity may remain, and if the septum has also been deflected, considerable inconvenience may be felt in consequence of obstruction to respiration through one or other nostril. In such cases, though a considerable period may have elapsed from the time of the accident, much may be done by forcible straightening to remedy the deformity (see *Diseases of the Nose*). The lateral cartilages, if separated from the nasal bones, should be carefully replaced, as if this precaution is neglected little can subsequently be done. Where, however, they are merely laterally deflected, the resulting deformity may be corrected by the use of a retentive apparatus.

FRACTURES OF THE UPPER JAW, or of the malar bone with depression of the zygomatic arch are occasionally met with in severe smashes of the face. They are often impossible to rectify, and considerable deformity frequently remains. Although much comminution may occur, necrosis, in consequence of the great vascularity of these parts, rarely results.

FRACTURE OF THE LOWER JAW is nearly always due to severe and direct violence. The fracture may extend through any portion of the bone, but commonly occurs a little to one or other side of the symphysis, the line of fracture being then usually vertical. In this situation, and indeed whenever the fracture involves the alveolar border, the mucous membrane of the gums is torn, rendering the fracture compound. It unites, however, nearly always like a simple fracture. Suppuration, however, may occur, when the pus commonly escapes into the mouth; or occasionally an abscess followed by a sinus may point externally. There is not as a rule much displacement; but when, as occasionally happens, there is a fracture on both sides of the symphysis, the central portion is considerably depressed by the action of the genio-hyoid and digastric muscles. When the line of fracture extends through the angle or ascending ramus, the fragments are held in apposition by the masseter on the outer, and the internal pterygoid on the inner side. The fracture may occasionally occur through the coronoid process or the neck of the condyle. In the latter situation the displacement is peculiar, the condyle on the injured side being drawn forwards and inwards by the external pterygoid muscle of that side, while the rest of the jaw is tilted over towards the injured side by the action of the opposite external pterygoid, which is thus left unopposed. This sign is of some importance in distinguishing such a fracture from a partial dislocation in which the jaw is drawn over to the side opposite the dislocation. *Signs.*—The common form of fracture may be readily distinguished by pain on mastication, dribbling of saliva, some irregularity in the line of the teeth, unnatural mobility of the fragments, crepitus, and a rent in the mucous membrane over the fracture. Fracture through the angle may be detected by crepitus and by slight mobility of the fragments on firmly grasping the ascending ramus and body of the jaw. Fracture through the neck may be known by the peculiar displacement before alluded to, and, perhaps, by crepitus on manipulation. *Treatment.*—The parts should be placed in apposition and kept at perfect rest. This can usually be done by a gutta-percha splint moulded to the chin (Fig. 123), and secured by a four-tailed bandage (Fig. 126). All movements of the jaw must be avoided, the patient being fed on slops introduced either behind the last molar tooth or through any space left available by the loss of a tooth. In placing the parts in apposition some difficulty may be experienced in consequence of a displaced tooth having slipped between the fragments. If the parts cannot be kept

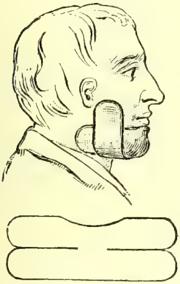


FIG. 123.—Gutta percha splint for fractured jaw. (Bryant's Surgery.)

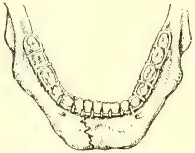
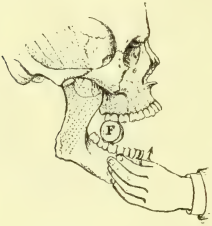


FIG. 124.—Dental splint applied.

in place by the simple splint above mentioned, they must be secured either by drilling the fragments and wiring them together, or by means of the dental splint shown in the accompanying drawing (Fig. 124). This splint consists of a wire frame fitted round the back and front of the teeth, and further secured by transverse wires between the teeth. One of the more elaborate, so-called interdental splints, may at times be found necessary. Union is usually accomplished in four or five weeks.

Dislocation of the lower jaw.—This accident may sometimes result from a fall or blow upon the chin with the mouth open, but more frequently occurs from spasmodic action of the external pterygoid muscles during yawning. When both condyles are displaced the dislocation is said to be complete; when only one is displaced, incomplete. *Nature of displacement.*—The condyle with the interarticular cartilage is drawn over the eminentia articularis into the zygomatic fossa, where it is firmly held by the contraction of the internal pterygoid, masseter, and temporal muscles. *Signs.*—The mouth is widely open and cannot be closed by any voluntary effort of the patient, and the saliva constantly dribbles away. In complete dislocation the symphysis remains in the middle line, and an unnatural hollow is felt behind each condyle. If the dislocation is partial the symphysis is carried over to the opposite side, and the hollow is felt behind only the dislocated condyle. *Treatment.*—The indications are to overcome the contracted muscles, and so allow the displaced condyle or condyles to be drawn by the temporal and deep fibres of the masseter, the retractors of the jaw, over the eminentia articularis into their sockets. A cork, or the thumbs, wrapped in a towel to avoid being bitten, should be placed between the last molar



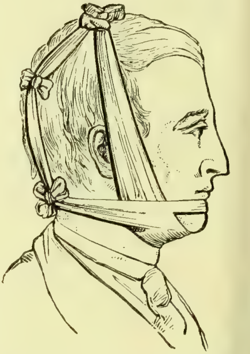


Fig. 125.—Mechanism of reduction of a dislocated jaw. F. Cork acting as fulcrum. The dotted lines represent the masseter and temporal muscles—the weight to be overcome by the hand or power.

Fig. 126.—The four-tailed bandage applied. (Bryant's Surgery.)

teeth of the upper and lower jaw on each side to act as a fulcrum while pressure is made in an upward direction on the symphysis by the surgeon's hands on the principle of a lever of the first order (Fig. 125). Whilst the symphysis is thus pushed upwards the condyle is drawn downwards, the weight, represented by the contracted muscles, being gradually overcome. As soon as the condyle is clear of the eminentia articularis it is drawn back into its place with a snap by the fibres of the retractor muscles. At times, in consequence it would appear of the coronoid process being wedged against the zygoma, reduction cannot be effected in this way. Downward and backward pressure by the protected thumbs will then generally succeed. A four-tailed bandage (Fig. 126) should be worn for a fortnight to prevent re-dislocation, which is very liable to happen.

The term SUBLUXATION OF THE JAW is applied by some to a displacement of the condyle from the interarticular cartilage; by others to an unnatural slipping forwards of the interarticular cartilage on the eminentia articularis in consequence of rupture or elongation of the ligaments. The latter condition is most frequently met with in delicate young people. The condyle catches, and the mouth cannot be closed for a second or two, but it can generally be replaced by the patient's voluntary efforts with a distinct snap. *Treatment.*—If counter-irritation and tonics do not succeed the joint may be opened and the cartilage secured in position by sutures.

INJURIES OF THE NECK, INCLUDING THE ENTRANCE OF FOREIGN BODIES INTO THE PHARYNX, ŒSOPHAGUS AND AIR-PASSAGES.

WOUNDS OF THE NECK.—Superficial wounds call for no special comment. Our attention here need only be given to wounds of the front of the neck, which are generally inflicted either with homicidal or suicidal intent. Such wounds are usually of the incised variety, more rarely punctured. They may be situated anywhere between the lower jaw and the top of the sternum, but are more common in the laryngeal region, especially through the thyro-hyoid membrane. Suicidal wounds are generally made obliquely from left to right and from above downwards, but may be transverse, and are commonly deeper on the left than on the right side. These facts are explained by the suicide generally using the right hand, and becoming less determined as he proceeds. There is usually but one gash, but there may be several, and again the gash may be superficial, or it may be deep, even extending to the spine. The structures involved will depend upon the situation, depth and extent of the wound. Thus, 1. When the wound is made above the hyoid bone the tongue may be severed, and the muscles that depress the jaw and elevate the hyoid bone divided together with the lingual or facial arteries and hyperglossal nerve. Such a wound will gape widely, and may open into the mouth, the food and saliva then escaping freely through it. 2. When the wound is through the thyro-hyoid membrane the pharynx will be opened and the epiglottis, aryepiglottidean folds or arytenoid cartilages, the superior thyroid and lingual arteries, and the superior laryngeal nerve may be cut through. The wound gapes less than in the preceding situation, but allows of the escape of food and saliva. There is usually great difficulty in swallowing. 3. When the wound is through the cartilages, the vocal cords and one or other of the intrinsic laryngeal muscles may be divided, with consequent loss of voice; the cartilages themselves, moreover, may be variously displaced. There is as a rule but little hæmorrhage. 4. When the wound is made below the cricoid cartilage the depressor muscles of the larynx, the inferior or superior thyroid artery, and the thyroid and anterior jugular veins may be wounded, the trachea partly or entirely cut across, and even the œsophagus implicated.

Wherever the wound is situated the carotid arteries generally escape owing to the resistance of the cartilages of the larynx, the deep situation of the carotids, and the contraction of the sterno-mastoid muscles.

Dangers.—The immediate dangers are—1. *Hæmorrhage.* When the carotid artery or jugular vein is wounded death is generally, though not invariably, instantaneous; but even when no large vessel is implicated, death before help is obtained is frequent from hæmorrhage from some of the arteries above mentioned, the external jugular vein, &c. 2. *Obstruction to respiration* in consequence of (*a*) the blood entering the air-passages in larger quantities than the patient can cough up; (*b*) the lolling back of the tongue over the glottis; (*c*) the displacement of the cartilages; (*d*) the separation of the divided portions of the trachea. 3. *Entrance of air into the veins* is also an occasional danger. *The subsequent dangers are*—1. Œdematous laryngitis; 2. Bronchitis and broncho-pneumonia; 3. Inflammation and suppuration of the loose tissues of the neck even extending to the mediastinum or pleura, and still later, 4. Obstruction of the air-passage, with increasing dyspnœa or loss of voice from (*a*) constriction during cicatrization, or (*b*) formation of prominent granulations; and 5. Œsophageal or tracheal fistula.

Treatment.—The hæmorrhage must be arrested; the air-passages cleared when obstructed with blood, by suction if necessary; and artificial respiration resorted to if the patient has already ceased to breathe. If the tongue or epiglottis is divided it must be fixed by sutures, or if a portion of the epiglottis is loose it may be cut off. The wound, unless quite superficial, should not as a rule be approximated by suture or strapping, but by position, the patient being propped up by pillows and the head bent forwards. The cartilages of the larynx, if displaced, may be brought together by suture, as may also the trachea, if divided. When the œsophagus is wounded the edges may be united by suturing the muscular coat, the mucous membrane being turned inwards, and the patient fed by a tube passed through the mouth and beyond the wound, or at first entirely by the rectum. Tracheotomy may have to be performed if respiration is embarrassed by displacement of the laryngeal cartilages or by œdema of the glottis. When the air-passages are opened the precautions described under *Tracheotomy* must be taken to prevent lung-trouble. Suppuration must be watched for, and free exit given to pus as soon as detected.

CONTUSION of the larynx may be *caused* by blows or kicks of all kinds and manual compression as in garotting. *Symptoms.*—Pain, especially on handling, localized swelling or ecchymosis, alteration or loss of voice, and slight hæmoptysis when the mucous membrane is lacerated. Unless there is much bleeding there is usually no dyspnœa, though this may subsequently be present should spasm or œdema of the glottis supervene. Severe compression of the larynx is said at times to have been instantly fatal from spasm of the glottis. The *treatment* should be directed towards allaying pain and preventing inflammation. Thus, a lead and opium lotion or an ice-bag may be applied over the larynx, and all attempts at speaking prohibited. Should signs of œdematous laryngitis appear, leeches, followed by hot fomentations, may be placed over the thyroid cartilage, whilst scarification of the glottis, and if this fails and suffocation threatens, intubation of the larynx or tracheotomy must be performed.

SUBCUTANEOUS RUPTURE OF THE TRACHEA is a rare accident, but may be caused by any violence applied to the neck. It is attended by emphysema and dyspnœa, and is usually rapidly fatal. An incision should be made in the middle line of the neck and an attempt made to draw the lower end of the trachea to the surface, and to pass in a tracheotomy tube.

FRACTURE AND DISLOCATION OF THE HYOID BONE.—*Fracture* may be produced by any violence applied to the neck, especially a severe grip. The line of fracture is usually about the junction of the greater cornu with the body, but may occur in any situation. The usual signs are pain, increased on handling, on turning the head, and on moving the tongue; dysphagia or inability to swallow; hoarseness or aphonia; a sense of suffocation on protruding the tongue; mobility of the fragments and crepitus; sometimes cough and dyspnœa; hæmoptysis when there is laceration of the mucous membrane; and occasionally, later, signs of œdema of the glottis. *Treatment.*—The fragments should be replaced by the forefinger passed through the mouth, whilst the fingers of the other hand manipulate the bone externally, a gag and chloroform being usually necessary. The parts must then be kept perfectly quiet, and the patient fed on slops passed well to the back of the tongue.

What has been described as *dislocation* of the hyoid bone appears rather to be a condition of the parts due to relaxation of the ligaments attaching the thyroid cartilage to the hyoid bone.

FRACTURE OF THE CARTILAGES OF THE LARYNX.—The fracture may extend through either the thyroid or the cricoid cartilage, or through both. The thyroid alone is most usually fractured. *Cause.*—Direct violence applied to the part, such as a blow or a fall, or compression with the hand, as in garotting. The usual *signs* are pain, increased on speaking, on swallowing, and on handling; dyspnœa; cough; expectoration of frothy blood, and later, when inflammation has come on, of offensive pus; emphysema when the mucous membrane is injured; great swelling and ecchymosis; and on examination, irregularity, undue prominence or flattening of the cartilages, crepitus, and preternatural mobility.

The danger to be apprehended is obstruction to the respiration in consequence of—1, displacement of a portion of cartilage across the larynx; 2, spasm of the glottis from irritation of the fragments; 3, entrance of blood into the air-passages; 4, swelling from submucous extravasation of blood; 5, œdematous laryngitis; and 6, perichondrial abscess and necrosis of the cartilage.

Treatment.—If the parts are fairly in apposition all that can be done is to steady them with a bandage and suitably-shaped pads of lint. But when there is serious displacement with perforation of the mucous membrane, as evidenced by severe dyspnœa and spitting of blood, tracheotomy should be *at once* performed, as otherwise the patient runs an imminent risk of sudden suffocation. An attempt may then be made, with the hand manipulating the cartilage externally, and with the forefinger of the other hand in the pharynx, to rectify the displacement.

Injuries of the Pharynx and Œsophagus from within.

WOUNDS OF THE PHARYNX are not infrequently met with from falls with a pipe, stick, &c., in the mouth. They may be attended by severe hæmorrhage when the lateral walls of the pharynx are punctured, either immediately, or on removing the inflicting body, or later, from a portion of the stick or pipe being broken off and remaining as a foreign body in the wound where it has caused suppuration and ulceration of a vessel.

Treatment.—Any bleeding vessel seen should be secured, or failing this, pressure must be made with a stick wrapped round with lint or solid perchloride of iron applied. As a last resource the common or external carotid must be tied. Should a foreign body be seen in the wound it should not be removed till preparations have been made (as for tying the carotid) to effectually arrest any hæmorrhage which might follow its extraction.

Injuries of the œsophagus may be inflicted in attempts to remove a foreign body or to pass an œsophagus bougie; or its walls may be perforated by a fishbone, &c., or may occasionally be ruptured during vomiting. Fatal hæmorrhage from the aorta, and perforation of the pericardium, pleura, and posterior mediastinum, followed by inflammation and death, have occasionally resulted from such injuries. *Treatment.*—Where a wound is suspected, the patient should at first be fed entirely by the rectum, and subsequently given only fluids in small quantities, so as to allow the wound time to heal.

Burns and scalds.—Burns of the pharynx occasionally occur from the inhalation of flame, as in a gas explosion or from the clothes taking fire; scalds are more common, especially among the children of the poor, from drinking boiling water or inhaling steam from the spout of a tea-kettle. In neither of these injuries is the œsophagus as a rule involved. In the case of burns the flame sometimes appears to be drawn through the larynx into the trachea. The boiling water is generally ejected from the mouth and nose, and only affects the entrance of the larynx. Both burns and scalds owe their gravity to the fact that they are frequently followed by œdematous laryngitis. The scalded and white appearance of the mucous membrane and the history of the case generally make the diagnosis plain. *Treatment.*—The patient should be placed in bed in a warm room and carefully watched for signs of œdematous laryngitis. Should such supervene, the swollen mucous membrane at the entrance of the larynx may be scarified; but if this does not at once relieve, an O'Dwyer's tube should be placed in the glottis, or tracheotomy performed. In the slighter cases the application of a hot sponge to the larynx, the administration of small doses of antimony, tincture of aconite or calomel, or mercurial inunction may be tried.

Charring and certain chemical lesions from drinking corrosive liquids, strong acids, or alkalies, are not uncommon. The effects vary according as such liquids are taken intentionally or accidentally. In the former case, the larynx usually completely escapes, whilst the mouth, pharynx, œsophagus, and stomach, may be extensively injured. In the latter case, the fluid, on the discovery of the mistake, is expelled forcibly, and some of it thereby generally enters the larynx and nasal cavities, but little passes down the œsophagus. Here, as in burns and scalds, the chief danger to be apprehended is œdematous laryngitis. For an account of the effects that may follow swallowing corrosive fluids, the reader is referred to a work on Forensic Medicine. It need only be remarked here that should the patient recover from the immediate dangers, he may subsequently come under the care of the surgeon for stricture of the œsophagus, due to the cicatrization following the injury.

Foreign bodies in the pharynx and œsophagus.—Fish-bones, coins, false-tooth-plates, and portions of food are the bodies most commonly impacted in the pharynx and œsophagus. The situations at which they may become arrested vary with the nature of the body. Fish-bones, pins, and the like are easily caught in the loose folds about the tonsil and fauces, or may be impacted lengthwise across the pharynx. Larger bodies, as false-tooth-plates, coins, &c., commonly become lodged about the cricoid cartilage. The *symptoms* and *treatment* vary according to the nature and size of the foreign body. A large portion of meat arrested over the entrance of the larynx will give rise to urgent symptoms of suffocation (Fig. 130); and endeavours should be made to remove it instantly by the finger plunged into the throat. If this fails, laryngotomy should be done at once, and artificial respiration resorted to if the patient has already ceased to breathe. A fish-bone or pin may give rise to a pricking sensation with difficulty or pain on swallowing, and the patient will often be able to indicate the position where it has lodged. A search should be made for it in the mouth and throat, aided by the laryngoscopic mirror, or if it cannot be thus found, by the *x* rays; but it must not be forgotten that the symptoms in consequence of the body having scratched the mucous membrane may persist even after it has been dissolved or swallowed. The position of a metallic body such as a pin or coin can be very accurately made out by the aid of the *x* rays. If in the tonsil or about the fauces, it may be removed

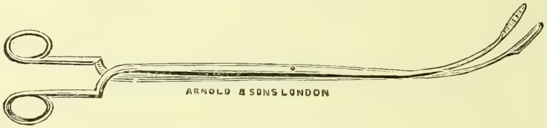


Fig. 127.—Pharyngeal forceps.

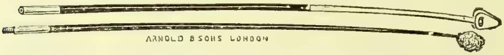


Fig. 128.—Coin-catcher and sponge probang.

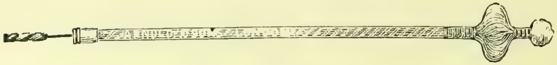


Fig. 129.—Expanding horse-hair extractor.

with the dressing forceps, or it may be hooked out from the upper part of the pharynx by the finger nail. If a foreign body is beyond reach of the finger, an attempt must be made to extract it by pharyngeal forceps (Fig. 127) or by some of the various forms of coin-catchers (Fig. 128), or the expanding horse-hair extractor (Fig. 129). The coin-catcher is a most useful instrument. I have removed a halfpenny with it that had been impacted in the œsophagus for some weeks. If, after a thorough trial, with the patient under chloroform, these means fail, pharyngotomy must be performed, and the body removed through the opening in the neck. When situated lower down the œsophagus, and it cannot be extracted by gentle means, it had better be left alone in the hope that it may become loosened in a day or two by ulceration, and be expelled or passed down into the stomach. Should this not occur, an endeavour may again be made to extract it or to push it onwards into the stomach with the sponge probang (Fig. 128). In these manipulations the greatest care must be taken, as if the body is sharp the œsophagus may easily be lacerated. Recently it has been shown that the œsophagus may be reached as it lies in the posterior mediastinum by cutting vertically midway between the scapula and spine, turning in the iliocostalis, and resecting a portion of the third, fourth, and fifth ribs. When the foreign body has been pushed into the stomach the patient should be fed on oatmeal porridge, and made to swallow portions of hair and the like, in the hope that the body, if angular, may become

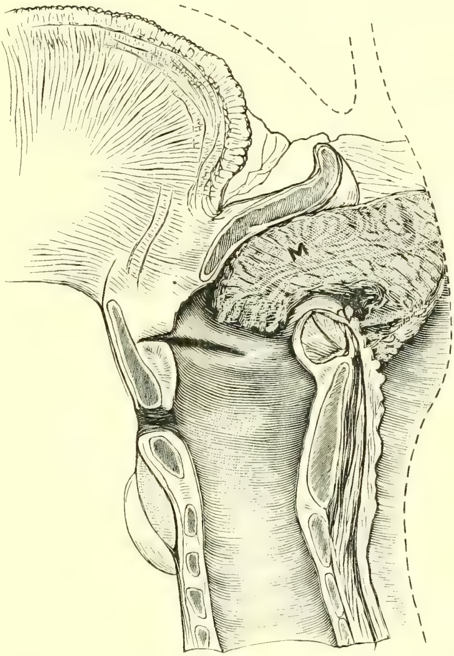


Fig. 130.—A portion of meat, M., firmly impacted in the entrance of the larynx. (St. Bartholomew's Hospital Museum, No. 1660 *a*.)

surrounded by this soft material and travel through the intestines without injuring them. Should it be too large to pass the pyloric valve, gastrotomy is the only resource.

FOREIGN BODIES IN THE AIR PASSAGES.—A foreign body may become lodged in the larynx, the trachea, or in one of the bronchi.

Foreign bodies in the larynx.—A foreign body may be lodged above, below, or between the vocal cords, or in the ventricles. When a voluminous body, as a piece of meat, becomes impacted at the entrance of the larynx, it may block up the passage, causing instant suffocation (Fig. 130). Smaller bodies, wherever situated, may also cause fatal dyspnœa by setting up reflex spasm of the muscles of the glottis; though in some cases a foreign body, such as a tooth-plate, may be so lodged between the cords as to prevent them closing. A foreign body in the ventricle may cause the same urgent symptoms. At other times the foreign body may give rise to severe, but not fatal, attacks of dyspnœa and spasmodic cough, though if not removed, inflammation and œdema will probably be set up, and the patient ultimately succumb. If it cannot be seen by the aid of the laryngoscope, its exact location may often be made out by the *x* rays. *Treatment.*—Where the symptoms are urgent and the body cannot be removed by the finger, instant laryngotomy should be performed. But when less urgent, a deliberate attempt should be made to remove it by means of laryngeal forceps aided by the laryngoscope, preparation having been made for instant tracheotomy lest sudden spasm of the glottis be set up by the manipulation. Sometimes, where extraction would be otherwise impossible, this may be accomplished by cutting the body in two by the use of the laryngeal cutting-pliers. These means having failed, an external operation must be undertaken. Thus, when the foreign body is above the cords, it may be removed by sub-hyoid pharyngotomy; when between the cords or in the ventricle, by thyrotomy; when below the cords, by laryngo-tracheotomy or tracheotomy, the forceps in the last instance being passed up through the wound in the trachea.

Foreign bodies in the trachea and bronchi.—Small objects such as coins, buttons, orange-pips, and fruit-stones, are liable to be drawn into the trachea during a sudden inspiration, while the patient is swallowing or is holding such in his mouth. The accident is most common in children. The foreign body may remain free or become impacted either in the trachea or a bronchus (Fig. 131). It is usually said to most frequently enter the right bronchus, that being the larger, and the spur-like projection at the bifurcation of the trachea directing it that way; but the left is the more direct route, and the direction it takes would seem to depend in great part on the shape and size of the foreign body. Thus an elongated body as the metal cap of a cedar pencil would probably enter the left, a rounded body, as a coin, the right bronchus. The *symptoms* vary somewhat, according as the body is free or impacted, light or heavy. When it is free and light, and, as is usually the case, has fallen into one of the bronchi, there will be sudden and paroxysmal attacks of suffocative cough and dyspnœa, in consequence of the foreign body being driven upwards against the glottis, which then closes spasmodically. On listening over the trachea it may be heard to strike the cords, whilst a tracheal râle may sometimes be detected, or, as it passes up and down, a whistling sound. During the intervals of the cough and dyspnœa, whilst the body is at rest in the bronchus, as is also the case when it is permanently impacted in it, there will be an absence of the breathing sounds over the whole or part of the lung on that side, according as the main bronchus or one of the secondary bronchi is obstructed; the resonance, however, will be normal or dull in places, according to the position and nature of the foreign body. If any air can pass the obstructing body, rhonchial or sibilant sounds may be heard, due in part to the bronchitis set up by it. Over the opposite lung puerile breathing may be detected. When the foreign body is heavy and of a rounded shape, it may act as a ball-valve, *i.e.*, it may allow air from the lung to be forced past it during expiration, but then fall back into a narrower part of the bronchus, and so prevent air entering during inspiration. In this way collapse of the lung is brought about. If the foreign body is not removed, or does not escape spontaneously, sudden death may occur during an attack of spasmodic dyspnœa: or it may set up bronchitis, pneumonia, or gangrene or abscess of the lung. At other times it induces more chronic changes, such as phthisis, or it may become encysted and no harm follow. In rare instances it may make its way out through the chest-walls by perforation or ulceration.

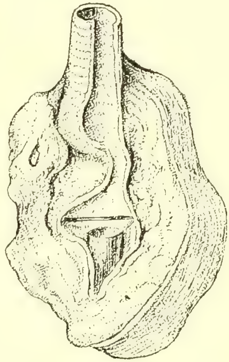


FIG. 131.—Foreign body in the right bronchus. The trachea is opened from the front. (St. Bartholomew's Hospital Museum.)

Treatment.—The patient should be inverted. Before doing this, however, everything should be in readiness for instant tracheotomy, n case the foreign body becomes lodged in the larynx and gives ise to spasm of the glottis. Children may be held up by the legs, ut for adults some special contrivance may be necessary, as, for nstance, Brunel's table. Inversion failing, tracheotomy should be erformed, as the patient is in danger of suffocation at any instant.

On opening the trachea, should the foreign body not be expelled at once, either through the wound, or, as sometimes happens, through the mouth, the patient may be again inverted, or search made for it through the wound with tracheal forceps, wire variously bent, &c. These means failing, the tracheotomy wound must be kept open to allow of future trials being made if the foreign body is not expelled during the interval.

PHARYNGOTOMY OR ŒSOPHAGOTOMY is the operation of opening the lower part of the pharynx or upper part of the œsophagus for the purpose of removing a foreign body. As the œsophagus inclines to the left, the operation by choice is done on that side, unless the body be felt distinctly on the right side. Make an incision about four inches long, having its centre opposite the cricoid cartilage, parallel to the sterno-mastoid, over the interspace between the great vessels and the larynx. Divide the platysma and deep fascia; draw the sterno-mastoid outwards, and the sterno-hyoid and sterno-thyroid inwards; and divide the omohyoid if in the way. Gently draw the larynx and trachea across the middle line in order to separate them from the great vessels; and then open the pharynx or œsophagus, as the case may be, by cutting on the foreign body if felt, or on the point of a sound passed through the mouth and made to project in the wound. Avoid injuring the superior and inferior thyroid arteries and the recurrent laryngeal nerve. The incision in the œsophagus should be united by sutures passed through the mucous membrane. The external wound should then be filled with iodoform gauze, and dressed antiseptically. The patient should be fed entirely by the rectum for some days after the operation or by a tube passed down the œsophagus and retained *in situ*.

Opening the œsophagus in the posterior mediastinum has recently been proposed for the extraction of a foreign body in the thoracic portion of the tube. (See *Stricture of Œsophagus.*)

INJURIES OF THE BACK.

SPRAINS of the spine are exceedingly common, and may be *caused* by any violent twist or bend of the back. The *pathology* of these injuries is hardly known. They are said to depend upon a partial tearing or rupture of the spinal ligaments, muscles or fasciæ, but opportunities for verifying this statement seldom occur. Sprains of the back may be complicated by concussion of the spinal cord, extravasation of blood in the subcutaneous tissue, or contusion or rupture of the kidney. They may, moreover, be followed by inflammation of the intervertebral joints and fibrous tissue about the spine; the inflammation may then at times spread to the membranes and cord, or be the starting-point of vertebral caries. *Symptoms.*—The patient usually complains of having ricked his back, *i.e.*, of severe pain localized to one spot, commonly the lumbar region, and increased on movement and pressure. On examination no definite injury, beyond, perhaps, some obscure swelling about the tender spot, or more rarely blood-extravasation, is discoverable. In the cervical region a sprain may sometimes simulate a dislocation, the pain causing the patient to hold the head in a fixed and one-sided position, thus rendering the transverse processes on one side of the neck more prominent than natural. In the lumbar region a severe sprain may sometimes simulate an injury of the spinal cord, inasmuch as the patient may complain of weakness of the legs or inability to move them, or may even experience some difficulty in defæcating or passing urine. It will be found, however, that in these cases no true paralysis exists, but that the apparent loss of power is due to the pain which is induced on attempts at movement. The *treatment* consists in rest, and the application of hot fomentations to relieve pain, and later of stimulating liniments. In severe cases the patient should be kept in bed for a week or so, and subsequently shampooing, massage, and galvanism may have to be employed to overcome the pain and stiffness which often last for some time.

Wounds of the spinal membranes and cord may be inflicted by stabs in the back, falls on sharp bodies, &c. When the membranes alone are wounded, there may at first be no signs except perhaps an escape of cerebro-spinal fluid; but later, should inflammation be set up, there will be the usual signs of spinal meningitis. A wound of the spinal nerves may be known by paralysis of the parts which they supply; a wound of the cord, by paralysis of the parts below the seat of injury. When division is complete the knee-jerk is quite lost, when incomplete the knee-jerk may be exaggerated. The *treatment* consists in placing the patient at absolute rest, and in keeping the wound perfectly aseptic to prevent inflammation; but if the cord has been divided, permanent paralysis will necessarily ensue. Should inflammation occur, the appropriate remedies for meningitis must be administered. (See work on Medicine.)

Dislocation and fracture.—Dislocation of the spine without fracture is exceedingly rare; indeed, except in the cervical region, it is said never to occur. Fracture unaccompanied by dislocation is also uncommon; but uncomplicated cases of fracture of the spinous processes and laminæ, and more rarely of the transverse and articular processes, are sometimes met with. In the majority of cases fracture and dislocation are combined. Thus, usually there is fracture of the body and articular processes of one or more of the vertebræ, with dislocation of the whole of the spine above the seat of injury from the spine below. This common form of injury is in the context spoken of as *fracture-dislocation.*

FRACTURE-DISLOCATION.—*Causes.*—It is either the result of *direct violence* applied to the spine, or of *indirect violence*, as a fall upon the head. 1. When the result of *direct* violence, which can only be applied to the posterior part of the spine, one or more of the spinous processes may be detached without implicating the vertebral canal. When the violence is very great, as in a fall from a height on the back across a beam or rail, or a severe blow as from a crane, the spine is bent violently backwards, tearing asunder the structures forming the anterior segment of the column, and crushing those forming the posterior. Hence the vertebral bodies are generally uninjured, but wrenched apart, the intervertebral cartilages are ruptured, the anterior common ligament is torn, and the arches of the vertebræ and the articular and spinous processes are crushed. The vertebræ above the injury are dislocated forwards, as the articular processes being fractured and the intervertebral cartilages torn, nothing remains to keep them in position. 2. In fracture from *indirect* violence (Fig. 132), such as may be received in a fall from a height upon the head, or catching the head whilst passing under an arch, or from a weight falling upon the head or shoulders, the spine is bent violently forwards, crushing the anterior part of the column and tearing the posterior asunder. Here one or more of the bodies and intervertebral cartilages are crushed between the vertebræ above and the vertebræ below, one of the fragments of the fractured body being frequently driven backwards into the vertebral canal, whilst the arches and the spinous and articular processes are wrenched asunder. Fracture of the sternum is occasionally combined with this injury, in consequence, it is said, of the chin coming into violent contact with the sternum as the spine is doubled forwards.

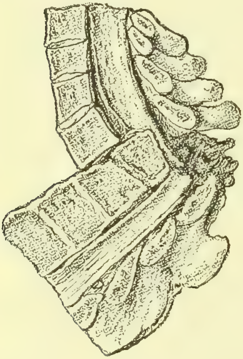


FIG. 132. — Fracture-dislocation of the spine. (St. Bartholomew's Hospital Museum.)

Condition of the spinal cord.—The importance of fracture-dislocation of the spine lies not so much in the fact that the vertebræ are fractured, as that the cord is generally injured. When the vertebræ are not displaced, the cord may at times altogether escape. More commonly, however, it is compressed, or perhaps, completely divided, or again so bruised that it rapidly undergoes inflammatory softening. When the injury is situated below the second lumbar vertebræ, the cord necessarily escapes as it terminates at that spot, but the nerves of the cauda equina may then be injured.

Signs and symptoms.—The local signs are often but little marked. There may be pain at the seat of injury, or some inequality in the spinous processes; but as often as not these are absent. The general signs depend upon the condition of the cord, and none will be present when it has escaped injury. But when it is compressed or crushed there will be paralysis of the parts below, more or less complete according to the extent of the lesion. Taking as an example a case of fracture in the lower cervical or upper dorsal region—the most common situation—with severe compression or crushing of the cord, there will be paralysis of both motion and sensation of the whole of the parts below the seat of injury (*paraplegia*), and perhaps a zone of hyperæsthesia immediately above the injured part. The intercostal muscles being paralysed, respiration can only be carried on by the diaphragm, this muscle receiving its nerve-supply through the phrenics which are given off above the seat of injury. Hence, while the chest is motionless, the abdomen rises and falls during respiration. The bladder and rectum and their respective sphincters share in the paralysis, so that there is at first retention of urine and fæces, followed by passive overflow of urine as the bladder becomes distended and will hold no more, and by involuntary passage of fæces. Priapism, or involuntary erection of the penis, is frequently present, or is induced by the use of the catheter. The temperature varies; sometimes it may be lower than normal, but often it is considerably raised, even reaching as high as 107° shortly before death. Consciousness, unless any head-injury has been received at the same time, is not affected. The reflexes in the lower limbs are usually at first in abeyance, but may return if the patient does not succumb to the shock of the injury. If the deep reflexes remain quite lost the probabilities are that the conducting power of the cord has been completely destroyed. If they return it is a sign that some power of conductivity is left in certain portions of the cord at the seat of injury. Death occurs, as a rule, from twenty-four hours to a few days from bronchial trouble; but the patient, if the fracture is in the upper dorsal region, may linger from two to three weeks. The secondary troubles which are then generally met with are *bed-sores* and *chronic cystitis*. 1. The bed-sores occur in situations subjected to pressure, and depend in great part on the congestion and lowered vitality of the tissues induced by the impairment of the nerve-influence; but they may also to some extent be due to the soddening of the part with the urine and fæces from which it is very difficult to keep the patient free. 2. The chronic cystitis is probably also due in part to impaired nerve-influence, and in part to slight injury in the passage of a catheter, or to the introduction by the catheter of micro-organisms—the

Micrococcus ureæ. The urine, which is at first acid, becomes ammoniacal from the conversion of the urea into carbonate of ammonia, and thick from the deposit of phosphates and the presence of ropy mucus. The inflammation may then extend up the ureter to the kidney, where suppuration of the pelvis and substance of the kidney (*pyelo-nephritis*) may be set up.

Such may be taken as a typical example of fracture of the spine as commonly met with in surgical practice. But the nature and gravity of the symptoms will depend upon the situation of the fracture, and the amount of injury to the cord. Thus in some cases of fracture there may be no paralysis; in others the paralysis may be incomplete, *i.e.*, confined to loss of motion only, or to paralysis of one limb or one group of muscles, or to impairment of sensation over some limited area. Such cases, however, are much less common than that above described.

Causes of Death.—1. When the fracture is above the fourth cervical vertebra, death is instantaneous in consequence of the severance of the phrenic nerves from the respiratory centre in the medulla. 2. In the lower cervical or upper dorsal region, death is due either to (*a*), hæmorrhage in the cord gradually extending to the origin of the phrenic nerves, or (*b*), a low form of bronchitis induced partly by hypostatic congestion, partly by defective nerve-influence, and partly by inability to clear the lungs effectually by coughing. 3. Later, death is commonly due to exhaustion produced by (*a*), the sloughing of the bed-sores, or (*b*), the pyelo-nephritis, induced in part by the extension of cystitis up the ureters to the kidney, and in part by the defective nerve-influence on the kidney structure.

The *prognosis* will depend in great measure on the situation of the fracture and condition of the cord. Thus, when the fracture is *in the cervical region*, if death is not instantaneous, the patient may survive from twelve hours to two or three days; usually, however, death occurs in about twenty-four hours. *In the upper dorsal region* the patient may linger for two or three weeks. *In the lower dorsal region*, if he survive the period at which the inflammatory troubles commonly occur, he may recover, remaining, however, if the cord is severely injured, paraplegic. *In the lumbar region* he may recover, with perhaps only partial paralysis of one or other of the lower limbs or of a certain group of muscles, or even without any paralysis whatever. But even where the injury to the cord has been so high as to cause paralysis of the whole body below the neck, patients have been known in rare instances to live for several months or even years.

Treatment.—1. In cases where there is no paralysis, thus showing that the cord is not affected, the indication is to keep the fractured spine at perfect rest, for the purpose not only of obtaining union of the fracture, but also of preventing by any movement displacement of the fragments and injury of the cord. 2. In the more common cases, where there is paralysis, showing that the cord is injured, the indications are to remove any fragments that may be compressing the cord, and subsequently to keep the parts at rest till union of the bones has occurred. 3. Where, however, as is too frequently the case, the removal of the fragments is not practicable, or the cord itself has been crushed, all that can be done is to endeavour to guard against the formation of bed-sores, and the occurrence of chronic cystitis and its attendant evils. Thus the patient should be placed upon a water-bed, and his posture gently changed from time to time, so that pressure may not be continuously made on one part, while he must be kept scrupulously clean and dry, and free from urine and fæces. The bowels should be cleared, if necessary, by enemata, or excessive diarrhœa controlled by morphia suppositories or starch and opium injections. Should bed-sores threaten, the skin should be hardened by sponging with rectified spirit, and dusted with oxide of zinc and starch powder. If formed, they should be dressed with mild antiseptics, iodoform, balsam of Peru, &c., and all pressure removed from the surrounding skin by the use of water cushions. To prevent cystitis from occurring a soft rubber catheter, thoroughly cleansed in carbolic acid and dipped in carbolic oil, should be passed twice daily. Should the urine become alkaline the bladder must be washed out with some antiseptic solution, as salol (gr. x to ℥ j) or boric acid (gr. x to ℥ j). *Extension and trephining of the spine.*—In cases where, from the marked inequality of the spinous process there is a probability of fragments pressing upon the cord, a cautious attempt to extend the spine and reduce the displaced vertebræ may be made, and a plaster-of-Paris case applied during the extension. In some instances it may be justifiable to trephine the spine (*laminectomy*) for the purpose of removing a fragment or extravasated blood; but space will not permit of the discussion of this interesting question.

CONCUSSION OF THE SPINAL CORD.—The term has been applied to various injuries of the cord received in railway and other accidents. It ought, however, to be restricted to those cases in which the cord is merely concussed or shaken; and the other injuries, such as hæmorrhage into its substance or into the arachnoid, contusions, and lacerations, all of which have been included under the term "concussion," described as spinal hæmorrhage, laceration of the spinal cord, &c. Concussion in this sense s one of the rarest of injuries, and need not detain us in a work of his character. For an account of the other lesions, and the very arious, apparently anomalous, and, as yet, far from understood ymptoms which may attend them, and which are generally classed ogether under the term of the "railway spine," a larger work must e consulted.

INJURIES OF THE CHEST.

Injuries of the Chest-walls.

CONTUSIONS may be produced by any sort of violence applied to the chest, and may be attended with laceration or rupture of the muscles, or with extravasation of blood into the tissues, which, again, may be followed by suppuration and abscess. They owe their chief importance, however, to the fact that they may be complicated by serious injury to the contained viscera, such as contusion or laceration of the pleura, heart, lung, or pericardium, or rupture of a large vessel in the mediastina. In some cases of severe contusion, in which death has occurred immediately or soon after the injury, without any lesion being found, the fatal result may be due to direct pressure on the heart, vagus or sympathetic, or to anæmia of the brain due to a sudden fall of blood pressure.

FRACTURE OF THE RIBS is a very common accident. *Cause.*—Generally external violence, rarely muscular action. 1. *External violence* may be—(*a*) *Direct*, such as the kick of a horse, a fall upon the edge of a table, &c. The fracture then occurs at the seat of injury, the fragments being driven inwards, occasionally injuring the thoracic, or more rarely, the abdominal viscera; or (*b*) *Indirect*, as the severe compression of the chest in a crowd. The fracture then generally occurs about the angle of the ribs, their weakest part, and several bones are usually broken. 2. *Muscular action.*—The ribs are sometimes broken in this way during violent coughing, or from straining during parturition.

Complications.—Fractures of the ribs may be complicated by an external wound; a wound of the pleura and lung, or pericardium and heart; laceration of a blood-vessel, as an intercostal artery; penetration of the diaphragm; and more rarely by perforation of the peritoneum, and wound of the liver or spleen. Hence they may be followed by emphysema, pneumothorax, hæmothorax, hæmoptysis, hæmopericardium, and later by pleurisy, pneumonia, pericarditis, or peritonitis.

State of the parts.—Fracture of the ribs is more common in the old than in the young, on account of the loss of elasticity as age advances. Like fractures of other bones, they may be simple, compound, or comminuted. The middle ribs are those usually affected; the first and second rib being protected by the clavicle, and the eleventh and twelfth being moveable, are not often broken. Fracture of the upper ribs is more serious than fracture of the lower, as the lung is more liable to be wounded.

Signs.—Severe stabbing pain is felt over the seat of fracture, and is increased on taking a deep breath, or on coughing. On drawing the finger along the rib, some irregularity may be detected. Crepitus is usually felt on placing the hand flat over the fracture while the patient breathes deeply, or it may be heard on listening with the stethoscope. Emphysema, *i.e.*, a crackling sensation, something like rubbing the hair between the fingers, may at times be felt on touching the part. It is nearly always due to a wound of the lung, the air being drawn into the pleura through the visceral layer during inspiration, and forced through the wound in the parietal layer into the subcutaneous tissue during expiration.

Treatment.—In an ordinary case the injured side should be strapped with adhesive plaster, so as to control the respiration on that side and thus place the fractured rib as much as possible at rest. A broad bandage in addition applied round the chest often gives relief. When several ribs are broken a shield of gutta-percha may be moulded to the chest-walls and strapped on. Union occurs by ensheathing callus in three or four weeks.

FRACTURE OF THE STERNUM is rare. It may be accompanied by fracture of the ribs or costal cartilages, separation of the ribs from their cartilages, and sometimes by fracture of the spine. *Causes.*—Direct violence; indirect violence in consequence of a forcible bend of the body, either backward or forwards; very rarely, muscular action, as during parturition.

State of the parts.—The line of fracture generally runs through the gladiolus, and may be transverse, oblique, or longitudinal, the lower fragment usually projecting in front of the upper; but at times the gladiolus is separated from the manubrium, a condition sometimes spoken of as *dislocation of the sternum.* The chief *signs* are pain, increased on deep inspiration and coughing, irregularity and crepitus at the seat of fracture, and emphysema if the lung is wounded. The fracture may be complicated by injury of any of the thoracic viscera, or by hæmorrhage or suppuration in the anterior mediastinum. *Treatment.*—Rest on the back, and the application of a bandage, if it can be borne, round the chest.

WOUNDS OF THE CHEST-WALLS may be divided into the penetrating and non-penetrating. The *non-penetrating* are of no serious consequence, and may be treated like wounds in other situations. The *penetrating* are those that pass through the parietes into the pleura, pericardium, or mediastinum, and may be complicated by a wound of the lung, the heart, a large blood-vessel, an intercostal artery, or the internal mammary artery. When the wound is small, and there are no signs of injury to the thoracic viscera, it is not always possible to determine whether it has penetrated the chest-wall; although the direction and situation of the wound, and an account of the way in which it was inflicted, may point to its having done so. Under these circumstances, the wound should on no account be probed, but the patient treated as if the wound had penetrated, and watched for signs of inflammatory complications. The symptoms and treatment will depend upon the viscus wounded. (See *Wounds of Thoracic Viscera.*)

Injuries of the Contents of the Chest.

These may be divided into injuries of the—1, pleura and lung; 2, pericardium and heart; and 3, large blood-vessels.

1. INJURIES OF THE PLEURA AND LUNG.—*Contusion of the lung* without an external wound may be produced by a severe crush of or blow upon the chest. The visceral layer of the pleura may or may not be lacerated. It is attended with paroxysmal dyspnœa, cough, localized dulness, and crepitation, followed in a few days by expectoration of rusty sputa. If the visceral layer of the pleura is lacerated, blood and air may escape into the pleural cavity, and there will then be in addition to the above, signs of hæmo-pneumothorax. The patient usually recovers in a few days, but pneumonia, pleurisy, or abscess or gangrene of the lung may occasionally ensue.

Wounds of the pleura and lung may be produced by the fragments of a broken rib, or by a stab or gunshot. When attended with a penetrating wound of the chest they are very serious. The pleura alone may be wounded, but more often the lung is injured at the same time. *Signs.*—No single symptom is sufficient to make it certain that the lung has been wounded; but where several of the following are present, the diagnosis becomes fairly certain. Thus, there may be severe shock, abdominal breathing, and cough with expectoration of frothy blood-stained mucus, or even of pure blood. If there is an external wound, there will be escape of air intimately mixed with blood, and accompanied by a peculiar hissing noise (*hæmatopnœa*); or if there is no external wound, emphysema in the region of the fractured rib. When the pleura alone is injured, a very rare accident, the signs are similar; but no blood is coughed up, and though air may escape from the external wound if there be one, it is not churned into a fine froth with the blood, as it does not come from the lung, but is simply drawn in and out of the pleura through the wound in the parietes during inspiration and expiration. *Complications.*—Hæmothorax, pneumothorax, emphysema, hæmorrhage, and later pleurisy and pneumonia (see *Complications of Injuries of Chest*). *Treatment.*—Absolute rest, ice to suck, opium to subdue pain, closure of the wound if small, or insertion of drain-tube if large, and antiseptic dressings, with such treatment as is appropriate for the complications that may be present (see below). If the pleura alone is injured, the external wound should be closed, unless any complication exists, and dressed antiseptically. If the wound is large and the bleeding from the lung continues, the lung should be exposed and the hæmorrhage stopped by ligature or plugging.

2. INJURIES OF THE HEART AND PERICARDIUM.—*Contusions, wounds, and rupture of the pericardium* may at times be produced by a severe crush of the chest-walls; but are more often due to the penetration of a fragment of a broken rib, or to a stab or gunshot. In the last two instances the heart is generally also involved. *Signs.*—Severe shock, hæmorrhage, the position and direction of the wound, and subsequently symptoms of pericarditis. The prognosis is always very serious, death usually occurring either from the effused blood impeding the heart's action, or from pericarditis. The *treatment* consists in absolute rest, the local application of cold, and if inflammation threatens, of leeches. Should the heart's action become seriously impeded by effused blood, serum, or pus, aspiration or free incision and drainage may be required. When there is an external wound it should be dressed antiseptically, the pericardium being sutured if practicable.

Wounds of the heart, especially when they penetrate one of its cavities and particularly an auricle, are generally instantaneously fatal from shock or hæmorrhage. Remarkable exceptions, however, occur, and patients have been known to linger for a few hours or a few days, or even to recover. *Signs.*—When not at once fatal, a wound of the heart is attended with great collapse, syncope, a fluttering pulse, and dyspnœa, and later with symptoms of pericarditis. The *treatment* is the same as that for a wound of the pericardium. Recently a wound of the heart has been sutured with partial success.

Rupture of the heart, though rare, occasionally occurs as the result of great external violence to the chest-walls, or of some sudden exertion on the part of a patient suffering from disease of the heart's substance. Death is as a rule almost instantaneous.

3. WOUNDS OF THE LARGE BLOOD-VESSELS, as the aorta or vena cava, are almost invariably and immediately fatal, and require no further comment here.

Complications of Injuries of the Chest.

The chief complications attending injuries of the chest are:—1, external hæmorrhage; 2, hæmothorax; 3, pneumothorax; 4, emphysema; 5, prolapse and hernia of the lung; 6, pleurisy; 7, pneumonia; 8, hæmopericardium; 9, pericarditis; 10, mediastinal abscess.

1. EXTERNAL HÆMORRHAGE in penetrating wounds of the chest-walls may come from:—(1), an intercostal artery; (2), the internal

mammary artery; (3), a wound of the lung; or (4), a wound of the heart or one of the large vessels. Hæmorrhage from an intercostal or the internal mammary artery, though it may generally be known by the blood escaping in jets, is sometimes difficult to distinguish from hæmorrhage from the lung. In such a case it is said that if a card be introduced into the wound, the blood, if it comes from an artery in the chest-wall, will flow over the outer surface of the card, but if it comes from the lung will well up around the card. Hæmorrhage from the heart or one of the large vessels is as a rule immediately fatal. *Treatment.*—1. An intercostal artery should, if possible, be tied; otherwise pressure-forceps may be left on, or the artery with the periosteum may be separated from the lower half of the rib and then tied, or a portion of the rib may be excised. Where assistance is not at hand, the centre of a sheet of lint (wrung out of an antiseptic solution) may be pushed into the pleural cavity and the hollow stuffed firmly with antiseptic wool. On drawing on the lint the artery will be compressed against the interior of the chest-wall, as shown in the accompanying diagram (Fig. 133). 2. The internal mammary in the four upper spaces can be easily tied; in the lower spaces a portion of the costal cartilage must be first cut away. 3. When the bleeding is from the lung the patient must be placed at perfect rest on the injured side, and an ice-bag applied. Internally, lead and opium, gallic acid, or ergot, may be given. Some recommend the closing of the external wound and the application of a bandage to the chest, so that the blood may collect in the pleura, press on the lung, and thus stop the bleeding.

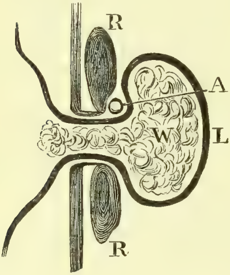


FIG. 133.—Method of compressing a wounded intercostal artery. A. Artery. L. Sheet of lint. R. R. Ribs. W. Plug of antiseptic wool.

2. HÆMOTHORAX, or hæmorrhage into the pleura, may occur either with or without an internal wound. It is, perhaps, most often due to a fragment of a broken rib penetrating the lung or wounding an intercostal artery. *The signs* are those of internal hæmorrhage with rapidly extending dulness to percussion, absence of breathing sounds, bulging of the intercostal spaces, and increasing dyspnœa. It may be distinguished from pleurisy and pneumonia by coming on immediately after the injury and by the absence of fever. *Treatment.*—Similar to that for hæmorrhage from a wounded lung. Should the breathing become dangerously embarrassed the blood must be drawn off with the aspirator. Should suppuration occur the chest must be opened and freely drained.

3. Pneumothorax, or air in the pleura, is generally the result of a wound of the lung by a fragment of a broken rib. It may be known by tympanitic resonance, absence of breathing sounds, or amphoric breathing, metallic tinkling, bulging of the intercostal spaces, and increasing dyspnœa. When combined with hæmothorax or with pleuritic effusion, the lower part of the chest will be dull to percussion, and a splashing sound on shaking the patient (*succussion*) may be heard on auscultation. The air is usually absorbed, but should the breathing become seriously affected, it may be removed with the aspirator or allowed to escape through a cannula left in the chest and protected by an antiseptic gauze dressing.

4. Emphysema, or air in the connective-tissue spaces, is sometimes called surgical emphysema to distinguish it from the medical affection of the same name in which the air-cells of the lung are dilated. It is generally due to a wound of the lung combined with a laceration of the parietal and visceral layers of the pleura, and is a very frequent complication of fractured ribs. The air either escapes into the pleura at each inspiration, and thence during expiration is forced through the parietal layer into the subcutaneous connective tissue, or it passes, if there are adhesions between the two layers of the pleura, directly from the lung into the subcutaneous tissue. More rarely it is due to a rupture of the lung without injury of the pleura, the air then escaping at the root of the lung into the posterior mediastinum, and thence into the connective tissue of the neck and arms. More rarely still it may occur without a wound of the lung, or even without a wound of the pleura. *Signs.*—The emphysema, though usually limited to the seat of injury, may extend somewhat widely around it, and in rare instances has spread over the whole body. It gives rise to an ill-defined flattened swelling unattended with signs of inflammation and unaltered on inspiration and expiration. On pressing on the swelling a peculiar crackling sensation is experienced, like that of rubbing the hair between the fingers. *Treatment.*—A pad and bandage is all that is usually necessary, but should the air instead of becoming absorbed extend so widely as to interfere with respiration, a puncture or two must be made to let it escape.

5. Prolapse and hernia of the lung.—*Prolapse* of the lung occasionally occurs through a wound in the chest-wall. It should be returned by gentle pressure, the wound being slightly enlarged if necessary. If the prolapsed portion has become adherent and congested it may be removed by the knife or ligature, taking care not to break down the adhesions of the visceral layer of the pleura to the chest-wall and so open the pleural cavity. *Hernia of the lung* is sometimes met with after a penetrating wound of the chest has cicatrized, or even when there has been no wound of the skin.

It forms a soft, crepitating, resonant swelling, which can be made smaller by pressure, and generally becomes more prominent on forced expiration or coughing. On listening over it a harsh vesicular murmur is heard. The *treatment* consists in protecting it with a properly-shaped pad or leather shield moulded to the part.

For an account of such complications as *Pleurisy*, *Pneumonia*, *Hæmopericardium*, *Pericarditis*, and *Mediastinal Abscess*, a work on Medicine must be consulted.

OPERATIONS ON THE CHEST.—*Tapping the pleura* should be done when the effusion is serous without admitting air, either with the aspirator or with the syphon-trocar and cannula. The spot usually selected is the sixth intercostal space in the mid-axillary line. A small incision is sometimes first made through the skin, which should be drawn down on the rib so that the wound may be valvular, but such an incision is quite unnecessary. The needle of the aspirator or the trocar and cannula is then thrust into the pleural cavity. The fluid should be allowed to escape slowly, and its flow stopped for a minute or so if coughing occurs. The instrument must be withdrawn should any blood become mixed with the fluid. The wound should be closed with a pad of antiseptic gauze.

Incision and drainage of the pleura may be required for empyema, the removal of putrid clots, &c. The incision may be made in the sixth intercostal space in the mid-axillary line, or in the ninth or tenth space in a line with the angle of the scapula. Before operating it is a good rule to make sure of the presence of pus by puncture with an exploring syringe, and make the incision at the spot where it is found. An anæsthetic should be given, and a careful dissection made between the ribs down to the pleura, or a director may be thrust through the muscles into the pleural cavity and the wound sufficiently enlarged by passing a dressing forceps along the director and forcibly opening the blades. A drainage-tube should then be inserted. The pleura had better not be washed out, since during this procedure sudden death may occur. Even when foul the pus will usually become sweet in a few days after free drainage has been established. If the space between the ribs is insufficient a piece of a rib may be excised. The wound should be treated antiseptically, and if pus again collects a counter-opening may be made, but this is seldom advisable or necessary.

Thoracoplasty or Estlander's operation consists in removing a portion of several of the ribs, for the purpose of allowing the chest-walls to fall in, in cases of empyema where, after the pleura has been drained, the lung in consequence of adhesions does not expand. An incision three or four inches in length may be made obliquely downwards and inwards over the side of the chest, just in front of the latissimus dorsi, across the ribs the portions of which it is intended to excise. The edges of the wound being retracted to expose the ribs an incision is next made through the periosteum along the course of each rib for the required distance, the periosteum separated with a raspatory from both the outer and inner surface, and the rib then cut through with the saw or bone forceps at each end of the incision, the soft parts being protected by a spatula passed beneath the rib. If the pleura is greatly thickened a portion of the parietal layer should be cut away. The visceral layer may then be scraped.

Pneumotomy, or incising the lung, may be required for the purpose of opening an abscess or hydatid cyst, or of draining a phthisical, bronchiectatic, or gangrenous cavity, or for removing a foreign body. An incision is made down to the pleura, a portion of the rib being excised; if no adhesions exist the lung is then sewn to the pleura by stitches passed deeply by means of Hagedorn's needles. The wound is then plugged with iodoform gauze. After a few days, when adhesions have formed, a trocar and cannula connected with an aspirator is thrust into the cavity in the lung, the wound made by the cannula enlarged by dressing forceps and a drain-tube inserted. The patient should not be placed on his sound side during the operation lest the fluid pass into his sound lung.

Pneumonectomy, or excision of a portion of the lung for localized tubercle, has been successfully accomplished in a few cases. The pleura having been filled with aseptic air to cause collapse of the lung, is opened, the collapsed lung transfixed below the disease with a blunt needle armed with aseptic silk, the silk tied, and the lung cut away above the ligatures. This operation seems hardly justifiable, since when the disease is sufficiently localized to permit of removal, it is probably amenable to medical treatment. Excision of a portion of lung for malignant growth, except when the growth invades the lung from the chest-wall, can seldom be required, in that primary malignant disease of the lung in a sufficiently early stage is seldom diagnosed.

Tapping the pericardium.—In a large serous effusion the heart is in the upper part of the pericardium, the puncture, therefore, should be made with the aspirator or a simple hollow needle (West) in the fifth intercostal space in the left nipple line or immediately to the left of the sternum. In purulent effusions the puncture should as a rule be made in the third intercostal space in the left nipple line, but it may have to be made in other situations as the pus is often contained in pockets. Dr. West has had to make it even to the right of the sternum. Care should be taken not to injure the internal mammary or an intercostal artery, and not to thrust the needle through the left pleura or too deep lest the heart be punctured.

Incision and drainage of the pericardium may be required for pus in its cavity. An incision about two inches long should be made along the upper border of the fifth or sixth rib, beginning one inch from the sternum. When the pericardium is reached it should be freely opened, a drainage-tube inserted, and antiseptic dressings applied.

INJURIES OF THE ABDOMEN.

Contusions of the abdominal wall, especially when due to a sharp or sudden blow or a severe crush, should always be regarded as serious, as they may be complicated by grave internal injuries. Thus, the peritoneum may be lacerated, one of the viscera ruptured, or a large blood-vessel injured and blood extravasated into the peritoneum or subperitoneal tissue; whilst among the minor complications may be mentioned rupture of the rectus or other muscle of the abdominal wall accompanied by blood-effusion (*hœmatoma*) and possibly followed by suppuration and abscess. Even where no injury to a viscus has been sustained, a contusion of the abdomen is nearly always attended with shock which may be severe, and in some instances has been fatal, probably from injury to the solar plexus. The *signs* of a simple contusion are pain, ecchymosis, tenderness and swelling, with a varying amount of shock. A ruptured rectus will be indicated by pain on putting the muscle into action, and the presence of a gap, and later of a swelling from the effusion of blood. A blood-tumour will be known by its sudden occurrence, and absence of signs of inflammation. *Treatment.*—The patient should be treated as if he had sustained a grave injury, since it is impossible at first to say that such is not the case. Thus, he should be placed at absolute rest in bed, hot fomentations applied to the abdomen and hot bottles to the extremities, and opium given internally; whilst for precaution's sake for the first twelve or twenty-four hours nothing should be given by the mouth or only small quantities of iced milk. Where there is rupture of the rectus the parts should be approximated as much as possible by position. If a blood-tumour forms, cold should be applied, but it should on no account be opened unless suppuration occurs, as the blood will nearly always in time be absorbed.

Laceration of the peritoneum may occur from a blow or crush of the abdomen without injury of the viscera, and may be complicated when a large vessel has been ruptured by extravasation of blood into the peritoneal cavity or sub-peritoneal tissue. There are no special *signs* of this injury; but restlessness, a sensation of sinking, yawning, an anxious countenance, coldness and blanching of the surface when complicated by hæmorrhage, with an absence of vomiting and often of pain, are said to indicate it. Peritonitis nearly always quickly supervenes. *Treatment.*—Like that of peritonitis.

Suppuration and abscess may follow on any injury of the abdominal walls, or extravasation of urine; or may be due to the breaking down of a blood-tumour or syphilitic gumma, or to disease of the bones forming the walls of the abdomen or pelvis. The suppuration may be acute or chronic, superficial or deep. When deep it is very apt to be diffuse, and extend along the muscular planes or between the peritoneum and transversalis. When superficial, except as the result of extravasation of urine, it is generally circumscribed and often confined to the sheath of the rectus. *Signs.*—The acute form is attended with the general and local symptoms of inflammation, followed by those of suppuration, and subsequently, by the signs of an abscess. In the chronic form there will probably be no constitutional signs; but a localized swelling, either superficial or deep, will generally be present in which fluctuation may be detected. *Treatment.*—Early and free evacuation of the pus.

Rupture of the viscera.—The rupture of an abdominal viscus is always a most serious accident, and one which is frequently, though not invariably, fatal. *Cause.*—Generally a severe crush of the abdomen, as between the buffers of railway cars; or a kick or blow, or the passage of a wheel over the abdomen. *Pathology.*—Any of the viscera, except perhaps the pancreas, may be ruptured; but the liver, intestines, kidneys, and bladder are those most frequently injured. In rupture of the *liver* and *spleen* severe hæmorrhage into the peritoneal cavity, followed by peritonitis, ensues, unless the peritoneal covering escapes rupture, when no blood is extravasated. In rupture of the *stomach*, *gall-bladder*, and *intestines* their contents escape into the peritoneal cavity, setting up rapidly-fatal peritonitis, though in the case of the stomach and gall-bladder the more immediate danger is death from shock. Rupture of the intestine usually occurs where the duodenum joins the jejunum. The large intestine is rarely injured in consequence of its protected position. Rupture of the *kidney* is a less fatal accident, as the organ lies well behind the peritoneum; but when the crush is severe it may be attended with hæmorrhage or peritonitis. It is liable to be followed by perinephritic abscess. In rupture of the *ureter* urine is extravasated behind the peritoneum. For rupture of the bladder, see *Injuries of Pelvis.*

The *signs* of a ruptured viscus are often obscure, but great shock, extreme collapse, and intense localized pain, together with the history of a severe crush of the abdomen, point to such an injury having occurred. Beyond a surmise that one of the viscera has been injured, it may be quite impossible to localize the mischief. The following signs, however, may serve to indicate the probable nature of the lesion; thus—1. In rupture of the *liver* there may be pain in the right hypochondrium, perhaps a fracture of the ribs over the liver, symptoms of internal hæmorrhage, increase of the hepatic dulness in consequence of blood extravasation, and later, peritonitis, jaundice, and very occasionally diabetes. When the rupture is slight, or the peritoneal covering is not torn, the injury may remain unsuspected and the patient recover. Or after a few days the peritoneal covering may give way and peritonitis ensue. 2. In rupture of the *spleen* the signs are similar, save that the pain is referred to the left side, and there may be increase of the splenic dulness, and perhaps fracture of the ribs in that region. 3. Rupture of the *stomach* is attended with extreme collapse, and if not rapidly fatal, with intense pain in the region of the stomach, free gas in the peritoneal cavity and hence loss of liver dulness, and vomiting of blood, followed by peritonitis. 4. In rupture of the *gall-bladder* there is pain in the region of the liver, followed by localized or general peritonitis, and if the patient survive by distension with fluid of the peritoneal cavity and great emaciation; on puncture, a bile-stained fluid is withdrawn. 5. In rupture of the *intestines*, in addition to the collapse and intense pain radiating over the abdomen, there may be vomiting, first of the contents of the stomach, then of bile, and then of altered blood; blood in the stools; tympanites with dulness in the flanks; and, later, peritonitis. 6. When a *kidney* is ruptured there will probably be a history of a blow or other injury of the loin, increased frequency of micturition, blood-stained urine, urinary extravasation in the loin, pain and signs of bruising in the lumbar region, retraction of the testicle, and, later, pus in the urine, and signs of deep-seated suppuration (*perinephritic abscess*) or peritonitis. 7. Rupture of the *ureter* may give rise to a fluctuating retroperitoneal swelling containing urine, and blood will probably appear in the urine in a few days.

Treatment.—Whatever the nature of the injury, if there are signs of severe *internal hæmorrhage* laparotomy should be done, and an attempt made to stop the bleeding. In rupture of the *liver* the abdomen should be opened, the rent in the liver sutured, or, if this is impossible, plugged with iodoform gauze, the end of the gauze being left as a drain in the laparotomy wound. In rupture of the *spleen* the immediate removal of the organ is probably the best way of preventing death from hæmorrhage. In both injuries stimulants for rousing the patient from his collapse should be carefully avoided. In rupture of the *stomach* or *intestines* the abdomen should be opened, the rent sewn up by Lembert's sutures, and the peritoneal cavity thoroughly cleansed by irrigation with warm, weak boracic solution, or sterilized water. If the rent is not readily found, insufflation with hydrogen or air may reveal it. Subsequently the patient should be kept under the influence of opium if there is much pain, and nothing whatever be given by the mouth for the first twelve to twenty-four hours. Nutrient enemata and stimulants, if the strength flags, should be administered. In rupture of the *kidney* an incision in the loin or nephrectomy may become necessary. The swelling following rupture of the *ureter* may require tapping or free drainage.

WOUNDS OF THE ABDOMEN may be divided into the penetrating and non-penetrating, according as they do or do not involve the peritoneal cavity. Whilst ascertaining this point, the strictest antiseptic precautions should be observed.

NON-PENETRATING WOUNDS should be treated like wounds in other situations, especial care, however, being taken to establish a good drain, as should they extend deeply they are apt to be complicated by effusion of blood or suppuration in the sub-peritoneal tissue. They are liable to be followed by ventral hernia.

PENETRATING WOUNDS are such as involve the peritoneal cavity. They may be divided into the following :—1. Simple penetrating wounds without injury or protrusion of the viscera. 2. Penetrating wounds with injury, but without protrusion of the viscera. 3. Penetrating wounds with protrusion, but without injury of the viscera. 4. Penetrating wounds with both protrusion and injury of the viscera.

I. SIMPLE PENETRATING WOUNDS WITHOUT INJURY OR PROTRUSION OF THE VISCERA.—When the wound is large there will usually be no difficulty in ascertaining the fact that the viscera have escaped injury. If, however, the wound is very small—a mere puncture, or made obliquely, it may be difficult or impossible to say whether any injury to the viscera has been done, or, indeed, whether the abdominal cavity has been penetrated. In such a case it has hitherto been taught that the wound should on no account be probed for the purpose of settling the point, but the patient treated as if the wound had penetrated and had not injured the viscera. If all antiseptic precautions are taken, however, it is safer to thoroughly explore the wound, by enlarging it if necessary, so as at once to ascertain whether it has penetrated the peritoneum, and whether the viscera have escaped injury, and not to wait till the diagnosis is settled by the onset of peritonitis. Where there are signs of internal hæmorrhage no surgeon would, I presume, hesitate to search for the bleeding vessel. *Treatment.*—Large wounds should be thoroughly cleansed with weak boric acid lotion (2 per cent.), and united with fishing-gut sutures, which are usually passed through the peritoneum as well as the edges of the wound so as to bring the two free surfaces of the serous membrane into contact. If this is not done the discharge from the deep part of the wound may make its way into the peritoneal cavity and set up peritonitis. Greig Smith, however, advises that the peritoneum should not be included, since he holds that the wound unites more quickly and firmly when two raw surfaces are brought together. In the case of punctured wounds it has usually been the custom to merely close them and apply some antiseptic dressing. As a rule, however, it will probably be safer to enlarge them, and, having ascertained that the viscera have escaped, to treat them as described above. In any case the patient should be placed at absolute rest in bed and fed by the rectum or by small quantities of iced milk for the first few days. Many surgeons would give opium in small doses; but it is not necessary unless there is pain. Should peritonitis supervene it must be treated as described under that head.

II. PENETRATING WOUNDS WITH INJURY, BUT WITHOUT PROTRUSION OF THE VISCERA.—When the wound is large, and the injured viscus can be seen, the nature of the injury will probably be obvious. When, however, the wound is small, unless there be an escape externally of fæces, gas, bile, urine, or the contents of the stomach, there are no primary signs, with the exception perhaps of emphysema about the wound, absolutely diagnostic of a viscus having been injured. Intense pain and extreme collapse, if present, no doubt point to such an injury having probably occurred; but both pain and shock are so variable as really to afford little guidance. Later the presence of free gas in the peritoneal cavity and the escape of blood from the anus would make it highly probable that the intestine had been wounded. In a doubtful case of wound of the intestine the rectum may be inflated with hydrogen by Senn's rubber balloon. If the gut is wounded the gas will escape through the rent into the peritoneum and thence through the external wound, where it will ignite on applying a light, thus settling the diagnosis. In a doubtful wound of the stomach this viscus may be inflated by a tube passed through the mouth. The tympanites will be confined to the stomach if that viscus is sound, or spread to the rest of the abdomen and efface the liver dulness if it is injured. Any of the viscera may be implicated; but wounds of the liver, gall-bladder, spleen,

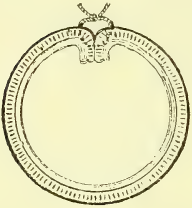


FIG. 134.—Section of intestine united by Lembert's suture.

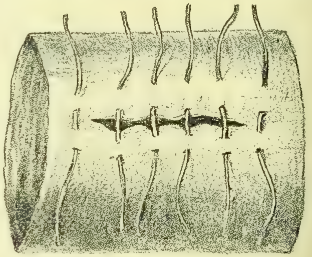


FIG. 135.—Intestine united by Lembert's suture.

and stomach, are much less common than wounds of the intestine. The danger to be apprehended is hæmorrhage in the case of the liver or spleen, extravasation in the case of a hollow viscus, and in all, peritonitis. The amount of extravasation will depend upon the size of the wound, and whether the viscus was distended or empty at the time of injury; when the wound is a mere puncture, there may be none. If the extravasation is but slight, or escapes externally through the wound in the parietes, it may be cut off from the general peritoneal cavity by a local peritonitis, and the patient recover. An extensive extravasation is always followed by diffuse septic peritonitis, which, unless surgical measures are undertaken, will certainly prove fatal in a few days. *Treatment.*—Before dealing with the injured viscus the stomach should be emptied by the syphon tube and the rectum and sigmoid by a warm salt and water enema. A subcutaneous injection of morphia and strychnine should then be given, and the external wound and skin cleaned by antiseptics. 1. If the wound in the parietes is extensive, the injured viscus, if the *stomach* or *intestine*, should be drawn gently through the aperture and the wound of its coats united by Lembert's or Halsted's sutures. Should the intestine be torn completely across, its continuity should be restored by one of the forms of circular enterorrhaphy. If its coats are much lacerated, the lacerated portions should be first excised. Modern methods have so reduced the time required for restoring the continuity of divided intestine that only in exceptional cases should the patient's general condition render it necessary to draw the injured gut into the wound, stitch it to the parietes, and make an artificial anus. In gunshot wounds of the intestines Senn's inflation method is useful in determining if there be one or more wounds. The rectum is

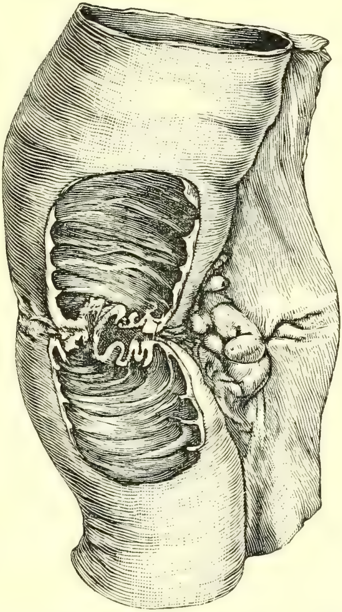


FIG. 136.—To show the ridge on the inner wall of the gut after circular enterorrhaphy by the Czerny-Lembert suture. This ridge may much diminish the calibre of the tube. (St. Bartholomew's Hospital Museum, No. 2040 *p.*)

first inflated and the lowest wound detected by the escape of the gas. This wound is then sutured, the inflation repeated, and the gas extends up to the next wound, and so on. If the *liver* is wounded an attempt may be made to unite the peritoneal surface by sutures, or if the wound is deep it may be plugged with iodoform gauze and the wound in the parietes left partially open for the purpose of drainage and the subsequent removal of the plugs. If the *gall-bladder* is penetrated the wound should be sewn up, or the edges of the wound if lacerated stitched to the abdominal parietes, or the gall-bladder removed. If the *spleen* is injured extirpation of the organ appears to be the best method of arresting the otherwise fatal hæmorrhage. After the wounded viscus has been treated in one or other of the ways described above, the infected portion of the peritoneal cavity should be thoroughly cleansed from all blood and other extravasation with aseptic sponges and left quite dry, or if the extravasation has been extensive, by irrigation with warm, sterilized water or boric acid solution (2 per cent.), and the wound in the parietes closed as after a simple penetrating wound; or if it remains doubtful how far the cleansing has been successful, a Keith's drain-tube or a roll of iodoform gauze surrounded with gutta-percha tissue, should be inserted, and the wound in the parietes left partially open. 2. If the wound

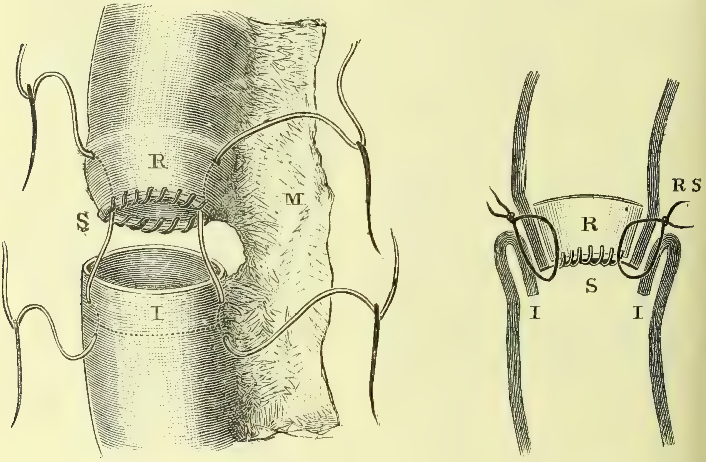


Fig. 137. Fig. 138.

Figs. 137 and 138.—Senn's method of circular enterorrhaphy. R. Rubber ring. S. Continuous suture. M. Mesentery. RS. Retaining suture. The margin of intestine, I. in Fig. 137, is shown turned in at I.I. in Fig. 138.

in the parietes is small it may be enlarged, and the wounded viscus treated as described above, or if more convenient, the abdomen may be opened in the middle line. The *general treatment* consists in the administration of opium if there is much pain; abstinence from all nutriment taken by the mouth for the first day or so, and subsequent feeding with small quantities of iced milk, &c., and the employment of nutrient enemata. Absolute rest is imperative. Should peritonitis supervene, it must be treated as described under that head.

Method of uniting wounded intestine.—If the wound is small (a mere puncture) it was usually taught that no suture was required, since the mucous membrane would protrude, block up the wound, and prevent extravasation until the wound had healed by inflammatory exudation from the peritoneal surface. Gross's experiments on dogs show, however, that the protrusion of mucous membrane is not always sufficient, even in minute wounds, to prevent the escape of fæcal matter. It is therefore better in all cases to sew up the wound, however small. This is now usually done by interrupted sutures, about $\frac{1}{8}$ inch apart, the two peritoneal surfaces being placed in contact. The sutures are best applied by Lembert's method, as shown in the accompanying diagram (Fig. 134), but the suture should pass not only through the peritoneal and muscular coats, but also, as advised by Halsted, through some of the firm fibres of the submucous coat, so as to ensure a better hold. The mucous membrane must not be included, since if this is done there is danger of peritonitis from leakage along the thread. The sutures, which may consist of fine China twist, should be introduced about two lines from the edge of the wound and brought out at the margin of the serous coat, and then passed in the same manner on the opposite side (Fig. 135). If, however, the edges are lacerated the sutures should be introduced further from the wound, and brought out a good line from the margin, so as not to include the bruised tissues. Sufficient sutures should be passed to ensure the parts being everywhere in apposition, and should not be tied too tightly, lest gangrene, the commonest cause of non-union, ensue. The peritoneal surfaces thus placed in contact unite by adhesive inflammation. The sutures either remain encysted, or ulcerate through the mucous membrane, and drop into the interior of the bowel. It is not safe to suture the wound—(1) when the wound runs longitudinally along the mesenteric aspect, inasmuch as gangrene of the part cut off from its vascular supply will inevitably ensue; (2) when suturing would reduce the lumen of the gut to more than half its normal size; (3) when there is much bruising of the gut; (4) when there are several wounds close together. In such cases the injured portion of the intestine should be excised and the two ends united by some form of circular enterorrhaphy, or an intestinal anastomosis may be formed.

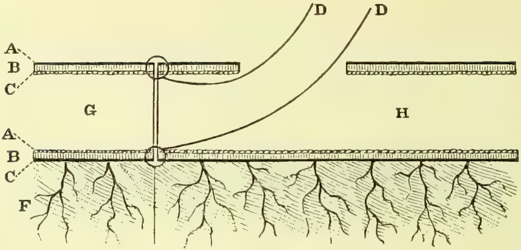


FIG. 139.—Maunsell's method of circular enterorrhaphy. A B C. Peritoneal, muscular and mucous coats. F. Mesentery. D D. Temporary sutures uniting proximal and distal portions of divided intestine, and passed out through longitudinal slit made in the proximal or larger segment of the intestine.

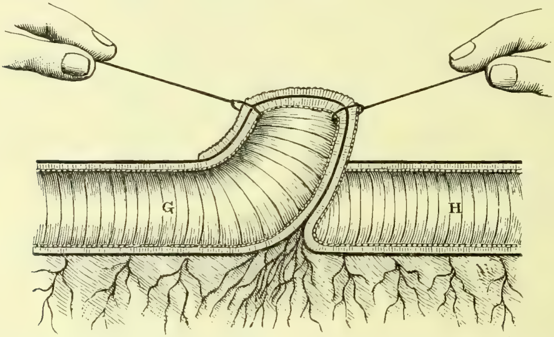


FIG. 140.—Maunsell's method of circular enterorrhaphy. G. The interior of the distal portion. H. The interior of the proximal portion of the bowel.

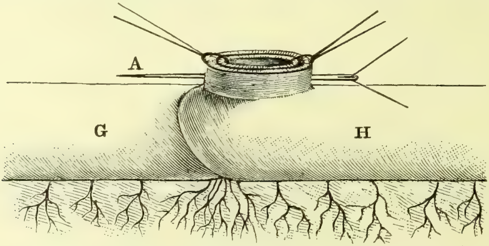


FIG. 141.—Maunsell's method of circular enterorrhaphy. G. The distal portion. H. The proximal portion of the intestine. A. The needle in transit.

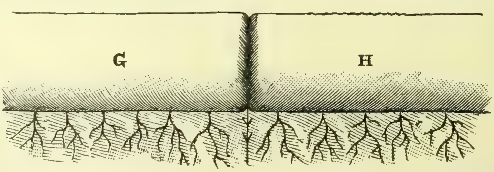


FIG. 142.—Maunsell's method of circular enterorrhaphy. Appearance o intestine at completion of operation. G. Distal portion. H. Proximal portion of intestine.

Circular enterorrhaphy is the union of the ends of the completely-divided intestine with the peritoneal surfaces in contact by a row of sutures around the circumference of the bowel. The Lembert method of a single row and the Czerny-Lembert method of a double row have in recent years usually been employed. The objection to these methods are—(1) The great number of sutures required, and hence the length of time consumed in the operation—a serious drawback in abdominal cases; (2) the danger of extravasation at the mesenteric attachment; and (3) the formation of a ridge on the inner surface of the gut which may seriously diminish the lumen of the tube (Fig. 136). Many, therefore, employ Senn's, Maunsell's, or Paul's method of suture; a continuous suture supported by Mayo Robson's decalcified bone bobbin; or in place of sutures unite the ends by means of Murphy's button. Others, instead of end to end union employ the lateral approximation method by Senn's plates, Murphy's button, or Halsted's method of suture.

Senn's method of circular enterorrhaphy.—Having determined which is the upper end of the intestine, as by applying to the surface of the peritoneal coat a little common salt, which causes ascending peristalsis (Nothnagel's test), line the lower end of the upper portion of the bowel with a soft pliable rubber ring half an inch wide, made by stitching together the ends of a rubber band by two catgut sutures. Fix the ring by sewing its lower margin with a continuous catgut suture to the cut end of the bowel; the ring prevents bulging of the mucous membrane and causes the end of the bowel to slightly taper, and thus aids its subsequent invagination (Fig. 137). Pass two catgut sutures with a needle at each end from within outwards through the upper margin of the ring and all the coats of the bowel, one suture near the mesenteric, one near the cenvex surface of the bowel. Pass the other end of the sutures through the peritoneal and muscular coat of the distal portion of the bowel about a third of an inch from its cut margin. Whilst an assistant draws on the four ends of the two sutures turn in the margin of the upper end of the distal portion of the gut evenly by the aid of a director, and at the same time invaginate the ring-lined proximal portion of the intestine into the distal portion (Fig. 138) to the extent of the whole width of the ring. Tie the sutures only sufficiently tightly to prevent disinvagination. The two peritoneal surfaces are thus held in close contact by the rubber ring. The intestinal contents, says Senn, pass freely through the lumen of the ring from above downwards, but escape from below is impossible, as the free end of the intussuscipiens secures accurate valvular closure. The catgut sutures fixing the ring are absorbed, and the ring, reconverted into a band, is passed per anum. The invagination sutures are believed by Senn to be removed by substitution on the part of the tissues. Hence the punctures of the bowel remain closed and extravasation is prevented.

Maunsell's method.—Bring the two ends of the divided bowel together by two temporary sutures passed through all the coats, one suture at the mesenteric attachment, the other opposite. The mesenteric suture should close the little triangle where the mesentery is reflected from the gut. Leave the long ends of the sutures intact.

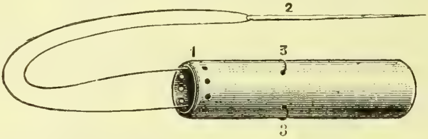


Fig. 143.—Paul's bone-tube, with double silk ligature for forming traction thread fixed to holes in the tube at 3 3. 1. Distal end perforated, with holes for sewing to bowel. 2. Needle.

Pass them up the lumen of the proximal portion of the bowel and out through a longitudinal slit previously made in its wall opposite the mesentery, and about an inch from its cut end (Fig. 139). Draw on the sutures, and the distal or smaller end G (Fig. 140) will be invaginated into the proximal or larger end H, and thence pulled out of the longitudinal incision in the wall of the proximal portion H. From Fig. 140 it will be seen that the serous surface of the two portions are in accurate apposition all round. Whilst an assistant holds up the intestine by the temporary sutures, drawing them gently apart so as to render the lumen of the invagination an oval slit, pass a straight needle armed with fine silk across the slit a quarter of an inch from the cut ends through the whole thickness of the four walls of the intestine (Fig. 141). Hook up the suture, divide it and tie each half. In this way twenty sutures can be passed in ten transits of the needle. When sufficient sutures have been applied, cut short the temporary sutures and reduce the

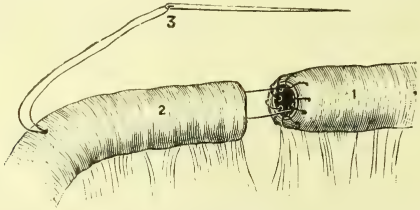


Fig. 144.—Gut ready for invagination in Paul's method of enterorrhaphy. 1. Proximal end of gut, with tube sewn in. 2. Distal end, with traction thread (3) passed through its wall.

invagination by traction on the two portions of the gut and close the longitudinal slit by a continuous Lembert suture. On the completion of the operation the peritoneal surfaces are accurately in contact, and the knots are all inside (Fig. 142). Maunsell paints the wound with Wölfler's mixture of alcohol, glycerine and colophonium, and dusts it with iodoform. The chief objection to the method is the infliction of the longitudinal wound.

Paul's method.—Insert a Paul's decalcified bone-tube, to which is attached a needle and double silk ligature to form a traction thread, (Fig. 143), into the proximal end of the intestine; sew this end of the intestine to the tube, closing the triangular interval at the mesentery. Pass the needle and traction thread through the lumen of the distal portion of the intestine, and bring it out through the wall three inches down (Fig. 144); unite the cut ends of the bowel by continuous suture; draw on the traction thread, and thus invaginate the upper into the lower portion, beginning the invagination immediately below the line of union; fix the invagination by Lembert's sutures (Fig. 145). Pull the traction thread tight; cut it off, and allow the ends to pass back into the bowel. The condition of the parts at the end of the operation is seen on section in Fig. 146. The bone-tube is disintegrated and passed per anum.

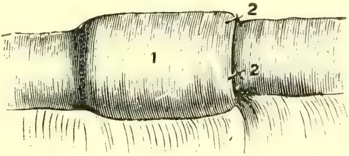


FIG. 145.—Condition of parts in Paul's method of enterorrhaphy when operation is completed. 1. The intussuscipiens. 2 2. Lembert's sutures.

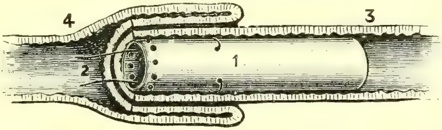


FIG. 146.—Section of parts shewn in Fig. 145. 1. Bone-tube. 2. Traction thread cut short. 3. Proximal end of bowel. 4. Distal end invaginated.

Mayo Robson's method (Figs. 147 and 148).—Take two curved sewing needles, one threaded with silk, one with catgut; the former is for the serous surfaces, the latter for the mucous margins. Apply the serous suture continuously around the distal half first, and lay aside the threaded needle until the mucous edges have been approximated by carrying the mucous or marginal suture continuously round the distal half of the circumference. Now insert the bobbin and continue the mucous stitch around the circle until the loose end of the catgut stitch at the starting point is reached,

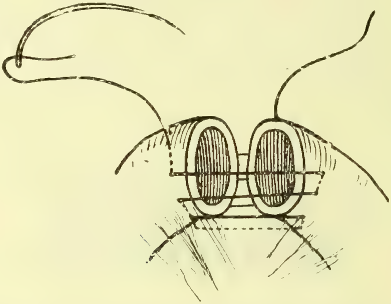


Fig. 147.—Mayo Robson's method of uniting divided intestine; application of serous stitch to distal half of gut before beginning the mucous stitch; the bobbin not yet inserted.

draw in the two ends of this stitch, tie and cut off short (Fig. 148). Finish the serous stitch in the same way. Both stitches are now buried, and only a line is seen where the union has been effected.

Murphy's method of uniting completely divided intestine by an anastomosis button.—By this contrivance an end to end approximation or a lateral anastomosis may be quickly accomplished without sutures. The button consists (Fig. 149) of two halves. The male half A has a spring flange P for keeping up pressure on the approximated intestine. The two springs *s s*, projecting through openings in the hollow stem, act as the male thread of a screw when the shank is telescoped within the stem of the female half B. The intestine having been clamped, as previously described,

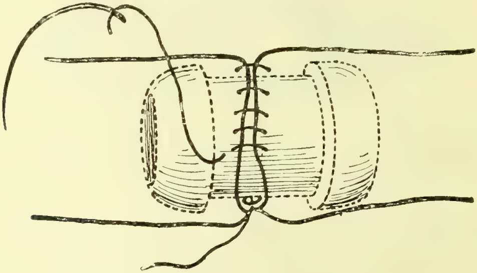


Fig. 148.—Mayo Robson's method of uniting divided intestine; the bobbin *in situ*; the mucous stitch nearly completed.

pass the running thread (Fig. 150) by the overhand stitch (*b*) round the cut end of the intestine, beginning and ending opposite the mesenteric attachment. One return stitch (*a*) should be taken at the mesenteric attachment to close the triangular interval (*c*) which exists at the reflection of the mesentery from the gut. Insert one half of the button in the end thus prepared, tighten the running thread so that the intestine is puckered up round the stem of the button, tie the ends of the thread and cut them short. Secure the other half of the button in a like manner in the other end of the intestine (Fig. 153). The method of holding the button during insertion is shown in Figs. 154, 155. Press the two halves together, and the peritoneal surfaces are held in close and accurate contact. The appearance of the part after the operation is complete is well shown in Figs. 151 and 152. To prevent leakage it is essential that the whole of the mucous membrane should be inverted before the approximation is made, and great care should be exercised in correctly passing the over stitch on the mesenteric attachment lest the peritoneum escape the grip of the button. The great advantage of the operation is the rapidity and ease with which the union of the intestine can be effected. In the instances in which I

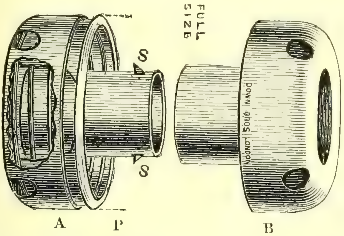


FIG. 149.—Murphy's button. A. Male half. B. Female half. P. Spring flange. *s s*. Springs projecting through openings in hollow stem. Part of the cap of the male half has been cut away at *c* to show circular spring which acts on flange. The round holes in the cap are for drainage.

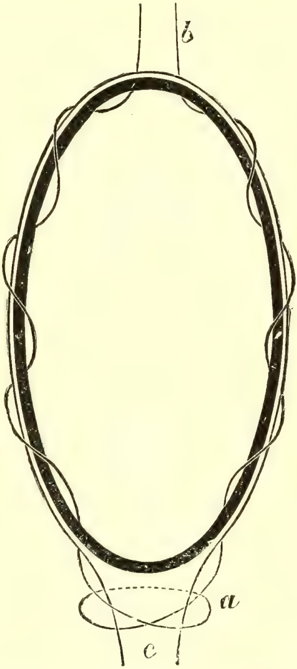


FIG. 150.—Method of applying "puckering thread" (*b*) preparatory to inserting the button. At *a* the method of applying the return stitch so as to close the triangular interval (*c*) at the reflection of the mesentery is shown.

have used the button, the operation took less than five minutes, and was followed by uninterrupted recovery. The disadvantages are—

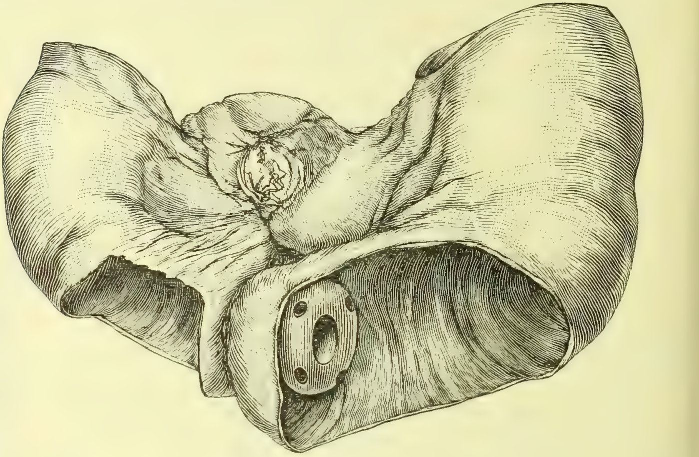


Fig. 151.—Murphy's button *in situ* from a patient who died twelve hours after an enterectomy. (St. Bartholomew's Hospital Museum, No. 2,040*q*.)

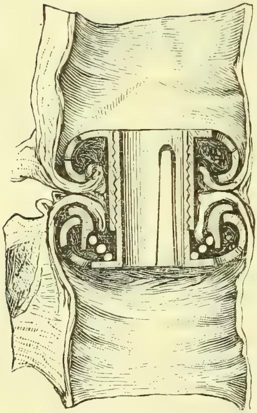


Fig. 152. — Longitudinal section through a piece of gut, the free ends of which had been joined by means of a Murphy's button after an enterectomy. The section has been made to show the mechanism of the button. The specimen was taken from a woman who died soon after the operation performed for strangulated femoral hernia. (St. Bartholomew's Hospital Museum, No. 2,040*q*.)

1. That a large foreign body is left in the intestine, where it may become a source of danger during its passage to the rectum, and 2. That since the button frees itself by causing gangrene of the compressed portions of intestine, whilst the adhesion of the serous surfaces occurs outside the grasp of the instrument there is perhaps a risk of the gangrene spreading too far and of perforation or non-union. However, whilst condemned by some surgeons the method is highly spoken of by others. I have myself the highest opinion of the method.

Lateral anastomosis of the intestine after complete division or excision of a portion may be done by Senn's plates, Murphy's button, or by Halsted's method of suture.

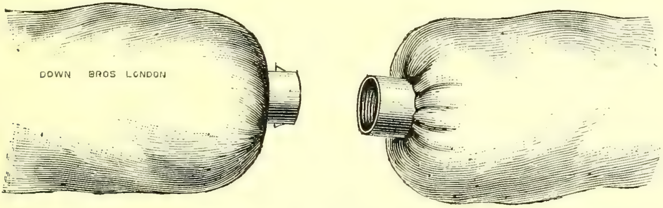


Fig. 153.—Murphy's method of end to end approximation of divided intestine. The male and female halves of the button are secured in the ends of the divided gut by the "puckering threads," and ready to be pressed the one into the other.

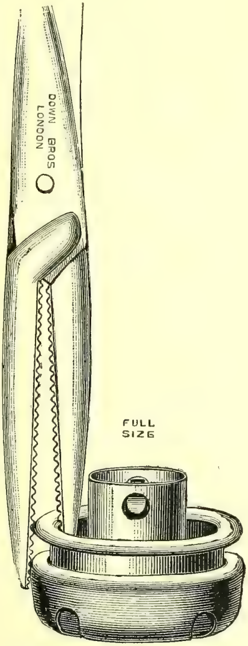


Fig. 154.

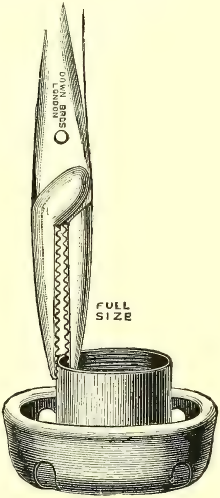


Fig. 155.

Figs. 154 and 155.—Showing method of holding male half and female half of button for insertion.

Senn's method.—Having let what fæces will escape from the proximal portion of the intestine, clamp both the proximal and distal portions about five inches above and below the divided spot by passing a piece of indiarubber tubing through a small incision in the mesentery and tying it sufficiently tightly to prevent any further fæcal soiling of the parts, or if the rubber tubing is not at hand the bowel may be clamped by a large safety-pin. Invaginate the divided ends with the peritoneal surfaces in contact and unite them by a continuous suture passed through the peritoneal and muscular coats (Fig. 156, A A). Make an incision, about an inch in length, along the convexity of each portion of the intestine between the sutured end and the rubber clamp. Insert into each incision a Senn's bone-plate properly threaded, as shown in Fig. 158, with four fine aseptic china silk sutures. Pass the

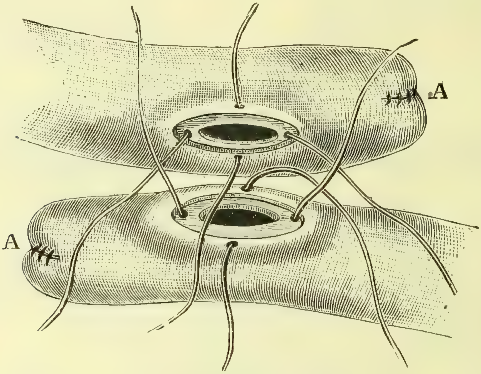


Fig. 156.—Method of forming a lateral intestinal anastomosis by Senn's bone-plates after complete division of the bowel. The divided ends of the gut closed by a continuous Lembert's suture, A A.

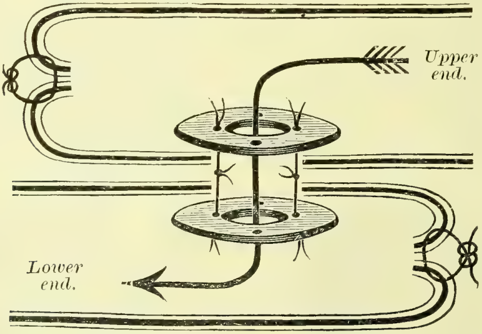
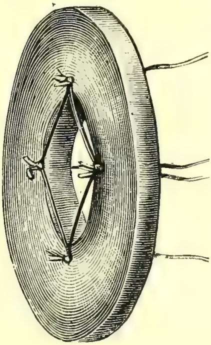


Fig. 157.—Diagram of intestine united by Senn's plates. The arrow shows the way in which the contents of the bowel pass through the plates and incision in the wall of the bowel from the proximal into the distal portion.

lateral sutures from within outwards through all the coats of the ntestine a line or two from the margin of the incision and bring the longitudinal sutures out through each end of the incision (Figs. 156, 157). Now place each portion of the intestine corresponding to the situation of the bone-plates opposite to each other, and having scarified the serous surfaces lightly with the point of a needle to aid subsequent adhesion, tie each of the four sutures coming from one bone-plate to the corresponding suture from the other, just sufficiently tightly to keep the wall of the intestine

Fig. 158.



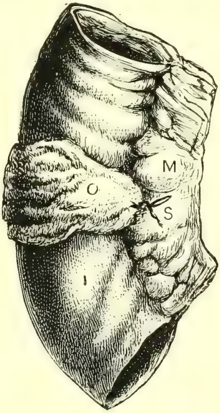


Fig. 159.

Fig. 158.—A Senn's decalcified bone-plate threaded ready for use. A fine china silk suture with a loop at one end, the size of the aperture in the plate, is passed through one of the suture holes, and to this loop the three other sutures passed through the three remaining holes are securely tied. The plates should be kept in alcohol.

Fig. 159.—Portion of intestine with line of suture covered by omental graft. I. Intestine. M. Mesentery. O. Graft. S. Suture fixing graft.

etween the plates in contact. Tuck in the knots between the pproximated serous surfaces and apply round the line of approxiation for greater safety an omental graft (Fig. 159). On removing e clamps the contents flow as shown by the arrow in Fig. 157, rough the central hole in the bone-plates and the incision in the alls of the gut from the proximal to the distal portion of intestine. he bone-plates hold the portions of intestine in contact, preventing y leakage of fæces till firm union has occurred. They ultimately ecome dissolved, and, together with the sutures, are passed per um. The advantages of this method over circular enterorrhaphy practised by the Lembert and Czerny-Lembert suture are that can be done in a much shorter time (a quarter of an hour ?) and hence greatly minimizes the risk from shock. It also appears attended with less danger of septic peritonitis from the possibility of leakage between the sutures or the penetration of the mucous coat by one of the Lembert stitches.

The *omental graft* is made by cutting a piece of omentum about an inch wide sufficiently long to encircle the intestine (Fig. 159). It is placed over the line of union and fixed by catgut sutures to the mesentery, the stitches being parallel to the mesenteric vessels. It adheres very rapidly to the intestine, but this adhesion may be accelerated by lightly scarifying the peritoneal coat of the intestine to which the graft is to be applied. It is of service in preventing extravasation should a leakage occur through a stitch-wound, &c.

Murphy's method.—The technique of lateral anastomosis with Murphy's button is similar to that of the end to end approximation, and requires no separate description. (See Fig. 160 for the way of passing the running thread.)

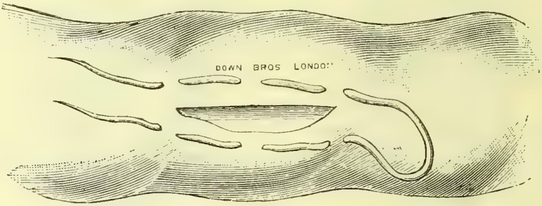


FIG. 160.—To show the method of passing the running thread for fixing the half-button in Murphy's method of lateral anastomosis of intestine.

Halsted's method of lateral anastomosis is done without the aid of plates or button by suturing the two portions of the intestine laid side by side together. A double row of Halsted's square sutures (p. 383) are inserted behind the spot chosen for the incision and tied, thus fixing the two portions of intestine together. Another row of sutures is next inserted in front of the spot for the incisions, and drawn aside whilst the incisions are made into each portion of the gut. The anterior row of sutures is then tied.

The choice of method of uniting a completely divided intestine will necessarily vary according to the condition of the patient, the state of the intestine and the skill of the surgeon. No one of the methods described can be said to be the best. All may be useful under certain conditions. There is a general tendency, however, amongst surgeons to dispense with artificial aids, such as bone-plates, tubes, rings and buttons, and to employ the simple methods of suturing, or merely to support the bowel during the suturing by some simple contrivance such as Mayo Robson's bobbin. No hard and fast rules can be laid down. When, however, the calibre of the divided ends is equal, the bowel healthy, the patient's condition good, a simple end to end suture, aided by Mayo Robson's bobbin is perhaps the best. But if the patient's condition is such that time is the chief object, then the end to end union by Murphy's button commends itself. When the calibre of the divided ends is unequal, a lateral approximation may be made by simple suturing by Halsted's method, or if rapidity is desirable, by Murphy's button or by Senn's plates. Opinions, however, differ widely on these matters, and the above indications are only given on my own experience and observation.

III. PENETRATING WOUNDS WITH PROTRUSION BUT WITHOUT INJURY OF THE VISCERA.—The protruding viscus is nearly always a portion of intestine or omentum. It should be cleansed with some weak antiseptic lotion, and returned by gentle uniform pressure into the abdomen, care being taken not to force it between the peritoneum and fascia transversalis. If the wound of the parietes is too small to allow the viscus to be returned easily, it should be cautiously enlarged. The wound should then be closed in the way already described. If the portion of intestine is congested or inflamed, it should still be replaced. If gangrenous, however, it should on no account be returned, but the gangrenous portion excised and the continuity of the gut restored by one of the methods already described, and replaced in the abdomen. In exceptional cases it may be left *in situ*, an incision made into it, and an artificial anus thus formed. A congested portion of omentum should be ligatured and cut off, and the stump returned; a gangrenous portion should be cut off, and the stump, which is probably already adherent, separated from the parietes, ligatured at a healthy spot, the diseased part cut away, and the stump returned. Great care should be taken if the wound is of a punctured character to ensure the closure of its deeper parts lest a hernia subsequently occur. The danger of this is well illustrated in Fig. 161. The general treatment hould be the same as that before described.

IV. PENETRATING WOUNDS WITH BOTH PROTRUSION AND INJURY F THE VISCERA.—The protruded viscus is nearly always a portion f the small intestine, or a small knuckle of omentum. The wound hould be united by suture in the way already described, and the ntestine then replaced. If the intestine is completely divided it ay be united by one of the methods already described, and eturned; or an artificial anus, under some circumstances, may be ade. If the wound is high up the intestine the former procedure hould be the one adopted.

TRAUMATIC PERITONITIS may be set up by any of the injuries bove described, and may either remain localized as a simple flammation to the neighbourhood of the wound or other injury, , as is more frequently the case, may become diffused over the whole peritoneal cavity, when it may assume a septic character, and terminate in blood-poisoning from the absorption of the chemical products of putrefaction.

The *simple localized variety*, after gluing the parts together, and thus preventing the spread of the inflammation, usually subsides; but it may terminate in suppuration and the formation of a circumscribed abscess, which may burst externally, into the intestine, or into the general peritoneal cavity, then setting up diffuse peritonitis.

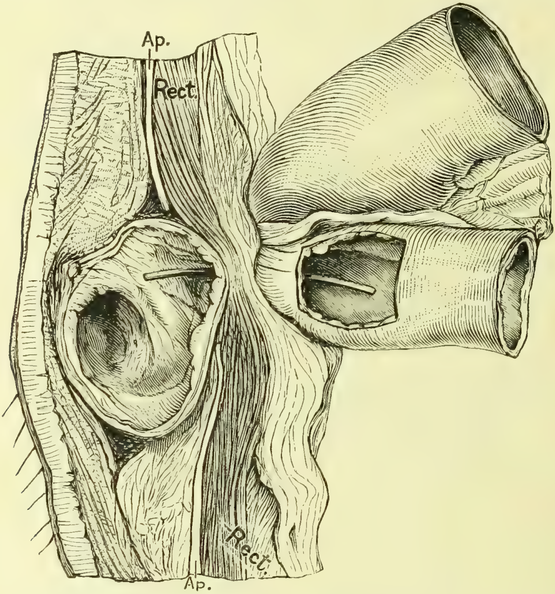


Fig. 161.—Traumatic hernia following a punctured wound of the abdomen. The wound healed by first intention, but four days after the injury a hernia appeared at its site and was reduced, but the reduction was incomplete, the gut having passed between the skin and sheath of the rectus and remained nipped at the opening through the sheath of the rectus; Ap., Aponeurosis., Rect., rectus muscle. (St. Bartholomew's Hospital Museum, No. 2,158 *a*.)

The *diffuse variety* is generally due to perforation of an ulcer of the stomach or intestine, and extravasation of their contents; to gangrene of a loop of intestine resulting from internal strangulation, or following on replacement of the bowel into the abdomen after operation for strangulated hernia. It may also be due to appendicitis; to the bursting of an abscess into the peritoneal cavity; to extravasation of urine, bile, or blood; or to septic infection during an operation, or by the infliction of an accidental wound

In addition to the ordinary pyogenic micrococci the *Bacillus coli communis* and the pneumococci often appear to be the organisms at work. The *Bacillus coli communis*, which is always found in the intestine, appears able to escape through the walls of the gut and infect the peritoneum when there is any breach or other alteration in the serous coat. The diffuse variety usually terminates fatally, sometimes in a few hours, usually within a week or ten days, either from collapse, or from blood-poisoning due to the absorption of septic products. Should recovery occur, death may subsequently ensue from intestinal obstruction consequent upon the gluing together of the intestines or the strangulation of a loop by a band of adhesion.

Symptoms.—In the *local form* there is severe pain at one part of the abdomen, increased on pressure, on deep inspiration, and on coughing, with perhaps vomiting, and a slight rise of temperature, followed, should an abscess form, by a circumscribed swelling, rigors, and fever. In the *diffuse variety* the pain, which at first may be localized to the seat of wound or injury, becomes general and of a lancinating character, and so increased by the slightest pressure that the weight of the bedclothes in a severe case cannot be borne. The patient lies on his back with his legs drawn up to relax the abdominal parietes, his breathing being entirely thoracic. The abdomen is at first hard owing to the spasmodic contraction of the muscles, but soon becomes distended and tympanitic, the paralysis of the muscular coat of the intestines allowing them to become inflated with gas. Where the peritonitis is the result of perforation the free gas in the peritoneal cavity may efface completely the liver dulness. Later, as effusion occurs, the abdomen becomes dull in the flanks. The general symptoms are obstinate vomiting, usually constipation, hiccough, a furred, dry, and brown tongue, a small, quick (140 to 160), and wiry pulse, and exhaustion and collapse. The temperature may register 103° or 104°, but it generally falls before death, or may remain little, if at all, raised throughout.

The *treatment* may be divided into the preventive and the curative. Preventive treatment consists in the prompt removal, where practicable, of the conditions which, if allowed to continue, are virtually certain to be followed by inflammation; and subsequently in keeping the patient at absolute rest, and allowing nothing to be taken by the mouth save small quantities of ice or hot water. By most surgeons opium in small and repeated doses is given; but by others the drug is only used if there is much pain, as it tends to restrain absorption from the peritoneal surface, and excretion from the intestines. On the first signs of peritonitis, a turpentine enema and a saline purgative (mag. sulph. ℥j.) may be given, with a view to causing the absorption of any serum that may have collected in the peritoneum. This treatment is advancing in favour, but it should be borne in mind that it ought never to be employed when there is any serious obstruction in the intestine, or where the peritonitis is due to perforation; in such cases it could only do harm. Where the abdomen has been closed, as after an ovariotomy, the wound may at times be opened with advantage, the peritoneum washed out and a glass drainage-tube inserted. In the way of curative treatment the only chance for the patient, where the inflammation depends on such causes as those above mentioned, is at once to freely open the abdomen, deal with any wounded viscus in the way already described, let out the gas from each distended coil by puncture with a fine trocar and cannula, and the fæces through a temporary incision, thoroughly irrigate the peritoneal cavity, and establish a free drain. Exhaustion and collapse should be met by strychnine and brandy before the operation, and afterwards by warmth, stimulants and nutrient enemata. The injection of normal saline solution into the veins has been recently tried with success. It raises the blood pressure, causes the elimination of the toxins circulating in the blood by the skin and bowels, and dilutes those that remain in the circulation. In the local variety, leeches followed by hot fomentations and turpentine stupes, may be employed, whilst, should suppuration occur, the pus should be cautiously let out.

INJURIES OF THE PELVIS.

Fractures of the pelvis.—*Cause.*—Nearly always severe and direct violence, as the passage of the wheel of a heavy van, or a crush between the buffers of railway carriages. The acetabulum, however, especially in old people, may be fractured from a fall on the great trochanter, or its rim may be chipped off in conjunction with dislocation of the hip.

State of the parts.—The injury may be localized to the acetabulum, or to the ramus of the pubes or ischium; or merely the anterior superior iliac spine or the crest of the ilium may be splintered off. When the result of a crush, the injury is generally more severe, the line of fracture often extending through the ramus of the pubes or ischium, and thence backwards through the ilium near the sacro-iliac synchondrosis, thus detaching, as it were, one side of the pelvis from the other. Or the fracture, as shown in Fig. 162, may extend in various directions, more or less smashing both the false and true pelvis. At times the injury may be limited to a separation of the pubic symphysis or of the sacro-iliac symphysis, or even of both, when it is spoken of as dislocation of the innominate bone. The fracture owes its importance to the liability of the pelvic viscera to be injured. Thus the bladder is not infrequently ruptured; or the urethra torn across by a fragment of the pubic arch; or the rectum or intestines lacerated when the sacrum or the venter of the ilium is implicated.

Signs.—The history of the accident, and perhaps the mark of a wheel across the lower part of the body, will commonly direct attention to the possibility of a fracture. On grasping the crests of the ilia firmly, preternatural mobility or crepitus may be discovered and pain produced, whilst the patient is usually unable to walk or to turn himself in bed without great suffering. A displaced fragment may sometimes be felt through the vagina or rectum. There is usually considerable shock, and where any of the viscera have been ruptured, commonly severe collapse. (See *Rupture of Bladder, Urethra, &c.*)

Treatment.—As the bone readily unites, little beyond keeping the parts at rest and in apposition is required. This may be done by applying a flannel bandage firmly round the pelvis and confining the patient to bed for three to five weeks, according to the severity of the fracture. Where there has been much crushing a gutta-percha or poroplastic felt shield should be moulded to the pelvis and hip of the affected side to prevent any movement of the fragments by the use of the joint. In any case a catheter should be passed in order to make sure that the urinary apparatus is not njured.

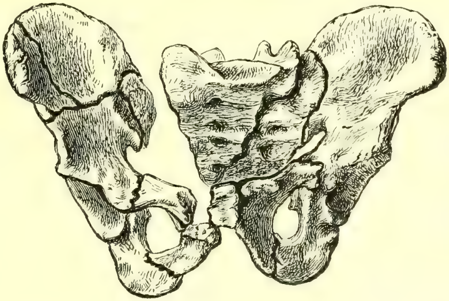


FIG. 162.—Fracture of the pelvis. (Bryant's Surgery.)

Fracture of the acetabulum.—A word or two in addition may be aid of this form of fracture of the pelvis. The rim of the acetabuum, generally the posterior and upper part, may be broken off n some forms of dislocation of the femur on to the dorsum ilii. esides the ordinary symptoms of the dislocation, crepitus will enerally be detected on manipulation, and the head of the femur ill slip in and out of the acetabulum. Or the fracture may extend through the floor of the acetabulum, the head of the bone being even driven into the pelvis. Crepitus may then be detected; or the head of the bone may be immovably fixed and the limb shortened. Pain is present on movement or on attempting to stand on the limb, also sometimes on pressing on the pubes. *Treatment.* —Extension may be made by a long splint, or by a stirrup, weight, and pulley.

Rupture of the bladder can only occur when the viscus is full. It may then be due to a blow or kick upon the abdomen, and is a frequent complication of fracture of the pelvis. Rupture is seldom due to over-distension consequent upon urethral stricture, as the walls of the bladder are then generally thickened and thereby rendered capable of resisting the pressure of the contained urine. Under these circumstances it is commonly the urethra behind the stricture that gives way.

State of the parts.—The rupture, which is usually vertical, may extend through the posterior part of the bladder, the urine escaping into the peritoneal cavity; or through the anterior part the urine then being extravasated into the loose cellular tissue of the pelvis. In the former case, which is the more common, acute peritonitis is generally set up sooner or later, according to the condition of the urine, and is, as a rule, fatal in a few days. In the latter, diffuse cellulitis commonly occurs, the patient succumbing either to septic poisoning from the absorption of the products of putrefaction, or to the extension of the inflammation to the peritoneum.

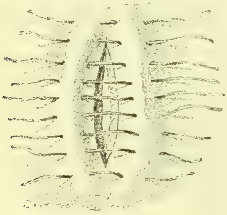


Fig. 163.

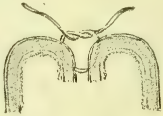


Fig. 164.

Figs. 163 and 164.—Method of applying Lembert's suture in ruptured bladder. (After Sir W. MacCormac.)

Signs.—Intense collapse following a blow over the abdomen or a severe injury of the pelvis, combined with the fact that on passing a catheter (as should always be done in such a case) no urine but only a little blood escapes, whilst the patient states that the bladder was full at the time of the accident, or at least that he had passed no water for several hours previously, should lead us to infer that the bladder is ruptured. The catheter, moreover, may at times be felt to be grasped by the empty bladder, and to slip through the rent in its walls; the point may then be detected more plainly than natural through the front of the abdomen, and blood-stained urine may flow. The flow, however, is not continuous, but varies with respiration. If the urine has had time to collect in the peritoneum, a sensation of fluid in the abdomen may be detected on palpation. Later, symptoms of peritonitis or of pelvic cellulitis will probably supervene. *Diagnosis.*—The signs, however, are not always obvious. Thus, there may be neither collapse nor pain; or, again, on passing a catheter, several ounces of clear urine may escape owing to urine having collected in the bladder in consequence of the rent being small or valvular, or blocked by a portion of intestine. If in doubt, ten or twelve ounces of some antiseptic fluid may be injected into the bladder, when, if no rupture exists, the bladder will rise out of the pelvis as during ordinary distension, and the same quantity should flow out again through the catheter. Or the bladder may be inflated with air or hydrogen: if there is an intra-peritoneal rupture the abdomen becomes distended and the liver dulness lost; if the bladder is sound a localized tympanitic tumour rises from the pelvis. In a case of ruptured bladder recently under my care the signs were obscure and the fluid test was not conclusive. Injection of a few cubic inches of air by the aid of the rubber ball of an ether-freezing microtome set the diagnosis completely at rest. The conclusions drawn from the experience of this case, the first in which the test has been applied, are—1, a few cubic inches of air is sufficient; 2, only very moderate pressure need be used; and 3, the introduction of air gives rise to profound shock, which passes off as soon as the abdomen is opened and the air let out. The air-test will probably enable the diagnosis to be drawn between an intra- and extra-peritoneal rupture, since in the latter emphysema of the connective tissue instead of distension of the peritoneum would probably be produced.

Treatment.—The following are the chief plans of treatment that have been adopted:—1. The retention of a soft catheter just within the bladder. 2. Washing out the bladder and adjoining portion of the peritoneal cavity with an antiseptic solution by a catheter passed through the rent in the viscus. 3. Washing out and drainage through an incision in the perineum. 4. Opening the abdomen, sewing up the rent in the bladder, and washing out the lower portion of the peritoneal cavity if the rupture is intra-peritoneal. Of these methods the last, provided every care is taken to ensure perfect closure of the rent in the bladder and thorough cleansing of the peritoneum by irrigation, holds out, in the intra-peritoneal rupture, the best prospect of success. Many cases have now been treated successfully in this way; amongst the first of these may be mentioned, two by Sir William MacCormac, one by Mr. Holmes, and two by myself. In sewing up the bladder the peritoneal surfaces should be brought into contact by Lembert's sutures (Figs. 163, 164), which should not pass through the mucous membrane. And one suture at least should be placed beyond the angles of the wound so as to prevent leakage at these spots (Fig. 163). After the rent has been closed a coloured antiseptic fluid (in both my cases I used milk) should be injected into the bladder to make sure that the viscus is watertight. A catheter should not be tied in, for fear of its inducing septic changes in the urine, but the patient should be made to regularly empty his bladder every four hours to guard against over-distension and the giving way of the sutures. When the margins of the rent are too lacerated to admit of coaptation, a long drain tube should be inserted in the bladder, and the peritoneal cavity around, after being cleansed, packed with iodoform gauze. When it is not clear whether the rupture is intra- or extra-peritoneal, the fundus of the bladder should be exposed before opening the reflection of the peritoneum. Extra-peritoneal rupture should be treated by a free incision in the perineum, or above the pubes, and an antiseptic drain. Nothing, as a rule, should be given by the mouth for the first twelve or twenty-four hours. Where, however, there is extreme collapse, stimulants may be cautiously administered. As in other peritoneal cases opium should only be used if there is pain.

Rupture of the urethra is a serious injury, as it exposes the patient not only to the immediate danger of extravasation of urine, but also to the lifelong trouble of a traumatic stricture. It is generally caused by a kick on the perineum, a fall astride a joist or rail, or the displacement of a fragment of the pubic arch in fracture of the pelvis. The urethra may also give way behind an old stricture while the patient is straining to empty his bladder.

State of the parts.—The rupture usually occurs where the urethra passes under the pubic arch, *i.e.*, either just in front of or just behind the triangular ligament. In the former situation urine and blood will be extravasated in the perineum; in the latter, about the neck of the bladder. As the triangular ligament, however, is generally torn, some urine will, as a rule, in the latter case also pass forward into the perineum. The urethra may be completely torn across, or the rupture may only be partial, the upper wall escaping.

The *signs* are usually quite obvious. Together with the history of an accident, there will be pain, swelling, and ecchymosis of the perineum, and escape of blood, often in considerable quantities, from the urethra. The patient is unable to pass water, and any attempt to do so merely forces more urine into the tissues of the perineum and gives pain. On trying to pass a catheter some obstruction is generally met with, and will often prove insurmountable; but if the catheter is finally passed, clear urine will escape. These signs distinguish it from ruptured bladder, in which injury the catheter passes easily, but as a rule (although the bladder is said to have been full at the time of the injury) only a little urine flows. In mere bruising and ecchymosis of the perineum the catheter will pass easily, and there is, as a rule, no escape of blood from the urethra.

Treatment.—In slight cases in which there is probably a mere bruising of the urethra and no retention of urine, all that is necessary is rest in bed and careful watching for any sign of extravasation in the perineum. If there is retention a soft catheter should be passed if possible; if not, a gum elastic or a silver one, and in any case tied in. Failing to pass a catheter or extravasation of urine in any quantity having already occurred, a silver catheter should be passed down to the obstruction, and a free incision through the middle line of the perineum made on its point. If the proximal end of the torn urethra can now be found, the catheter should be passed through it into the bladder and tied in. If not readily discovered, a prolonged search for it need not be made, as with a free incision through the perineum there is no danger of further extravasation of urine. Some surgeons, however, if they fail to find the proximal end of the urethra, do supra-pubic cystotomy and pass the catheter from the bladder. If the urethra is found only partially torn across, or if, though completely divided, its ends can be brought together, an attempt should be made to restore the canal by suture over a catheter, the external wound in the perineum being then united by deep sutures. The catheter should be kept in for a week. This procedure is attended, however, with some risk of extravasation, and could hardly be done where extravasation had already occurred, on account of the softened condition of the tissues. Should a fragment of the pubic arch be found compressing the urethra, steps must be taken to remove it, the bladder in the meantime being aspirated above the pubes to prevent further extravasation occurring. When the wound in the perineum is left to granulate in the ordinary way a silver catheter, as the point of this is more under control than that of a soft one, should be passed daily during the healing of the wound, and the patient enjoined subsequently to pass one for himself at frequent intervals, and warned that if he neglects to do so a stricture will gradually form.

INJURIES OF THE RECTUM occasionally occur from falls upon a sharp-pointed body, or incautious attempts to pass a long enema-tube or bougie. Should the peritoneal cavity be perforated, death is the almost invariable consequence, especially if any injection has been thrown into the peritoneum before the mistake is discovered. *Treatment.*—Opening the abdomen, flushing out the peritoneum, and sewing up the rent in the gut, holds out the only chance of escape.

FOREIGN BODIES IN THE RECTUM.—Foreign bodies of the most varied descriptions have at times been accidentally or intentionally introduced into the rectum. Fish-bones that have been swallowed not infrequently become impacted just within the anus, there giving rise to much irritation or pain, and often causing an ischio-rectal abscess. The removal of some of these bodies, when of large size, is frequently attended with considerable difficulty, requiring an anæsthetic, dilatation of the sphincter, and the use of various forceps, or even the passage of the whole hand. In a case under the care of Mr. Willett, the foreign body, a Liebig's extract-of-meat jar, could not be removed till the peritoneal cavity had been opened and the jar forced down by the hand.

INJURIES OF THE PUDENDA.—Contusions and wounds of all kinds may be met with, and require no special remark further than:—that ecchymosis of the loose cellular tissue is often extensive; that wounds, though apt to be attended with considerable hæmorrhage from the great vascularity of the parts, on this account also heal very readily; and that serious consequences from such injuries are exceedingly rare.

HÆMATOMA OF THE LABIA MAJORA sometimes occurs from injury, especially during pregnancy or parturition, the parts being congested at those times. The tumour may attain a large size, owing to the laxity of the tissues. The blood generally becomes absorbed, but suppuration may occur or the blood become encysted. The application of ice will generally control the hæmorrhage. A hæmatoma should on no account be opened unless suppuration takes place, when a free incision will be required.

WOUNDS OF THE VAGINA perhaps more frequently fall under the care of the obstetrician than of the surgeon. The surgeon, however, may be called upon to arrest hæmorrhage from this canal, consequent upon laceration inflicted by falling upon some sharp object, or the introduction of a foreign body. Washing out, the application of ice, or, if necessary, careful plugging with antiseptic gauze or with cotton wool soaked in perchloride of iron, will usually suffice.

PERFORATION OF THE WALLS OF THE VAGINA, with injury of the bladder, peritoneum, or intestines, is the occasional result of wounds of the vagina, and is usually fatal. The vagina should be washed out and the wound plugged with strips of iodoform gauze.

FOREIGN BODIES IN THE VAGINA.—Pessaries that have been introduced and forgotten by the patient, or possibly without her knowledge, are the foreign bodies most frequently found in the vagina, but various other articles have at times been met with. Their long retention here is often productive of a foul-smelling discharge, and may lead to the perforation of the walls of the rectum or bladder and an incurable fistula.

Foreign bodies in the female urethra and bladder.—Hair-pins introduced with the bent end forwards, are not infrequently pushed up the urethra into the bladder, where, if allowed to remain, they become encrusted with phosphates, and give rise to symptoms of stone. The urethra should be dilated, and the sharp ends of the hair-pin grasped by forceps, snared in a tube, or in some such way removed.

Ruptured perineum occasionally occurs during first, and especially instrumental labours. There may be a mere rent in the fourchette; or the rupture may extend from the vagina through the sphincter ani into the rectum, and involve more or less of the recto-vaginal septum.

Symptoms.—A rupture, when slight, gives rise to no special trouble; but when more extensive, there may be some prolapse of the posterior wall of the vagina with the contiguous wall of the rectum (*rectocele*), or of the anterior wall of the vagina and the part of the bladder in contact with it (*cystocele*), and, perhaps, some prolapse of the uterus. There may also be frequent micturition, and when the sphincter ani is involved, occasional incontinence of fæces. If the perineum is not sewn up immediately after the rupture the anterior end, *i.e.*, the vaginal mucous membrane, unites with the posterior end, *i.e.*, the rectal mucous membrane, so that the union of the sides is prevented and they remain wide apart. On viewing an old ruptured perineum, therefore, a transverse ridge marks the lower end of the recto-vaginal septum where the vaginal and rectal mucous membranes have come into contact.

Treatment.—An attempt to unite the parts should always be made immediately after the rupture by sewing up first the mucous membrane of the vagina, then that of the rectum and lastly the skin of the perineum by sutures inserted deeply. Should this fail, a plastic operation should not be undertaken until the vaginal discharge has ceased, the child been weaned, and the general health restored. The patient in the meantime should not be allowed to walk about, for fear of a prolapse of the parts. The bowels having been cleared by an aperient, and the rectum on the morning of the operation by an enema, the patient should be placed in the lithotomy position, and the skin dissected off from the sides of the fissure, and the mucous membrane from the recto-vaginal septum, so as to leave a raw surface of the size and shape shown in Fig. 165. The skin and mucous membrane should not be cut away as shown in the figure, but reflected towards the vagina. Care should be taken that the tissues are clean cut, and that the raw surface of the recto-vaginal septum is at least an inch broad, so that immediate and firm union when the parts are brought together may be obtained. Three or more deep sutures, consisting of strong silkworm-gut, should be introduced by means of a perineal needle. The first should be passed about an inch from the margin of the rupture deeply through the recto-vaginal septum, and, if the sphincter is ruptured, through its stump, and out at the corresponding spot on the opposite side. The next two sutures should be passed in the same way, only not through the septum. Fig. 165 shows the appearance presented by the sutures when *in situ* and ready for tying. The posterior suture should be first secured. Superficial sutures, after the fissure has been drawn together by the deep, should be used to keep the edges of the skin in contact. If there appears to be any tension, "incisions of relief" may be made through the skin on either side. Another method consists in making incisions like the letter H, the transverse splitting the recto-vaginal septum and the longitudinal extending along the sides of the vulva and anus. If the vaginal mucous membrane is now drawn well forwards and that of the rectum backwards, the wound is restored to the state it was in immediately after the rupture. Sutures may now be inserted as in a recent case, except that the perineal sutures, and especially the hindermost one ("the purse-string suture"), must be inserted more deeply in order to pull down the recto-vaginal septum and so restore again the perineal body. This method has the advantage that no tissue is pared away. *After-treatment.*—The patient should lie perfectly quiet on her back with the legs tied together, and the knees over a

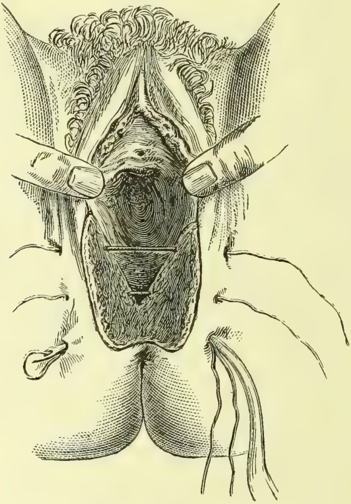


Fig. 165.—Operation for ruptured perineum.

pillow, and should keep her bed for at least three weeks. The urine should be passed on the hands and knees or be drawn off by the catheter. Some surgeons keep the bowels confined for three days to ensure rest to the wound, but as the fæcal relief may then endanger the adhesions, it is perhaps better to ensure a soft daily motion by gentle laxatives. The deep sutures should be removed at the end of a week or ten days, the parts in the meanwhile being kept clean by gentle syringing with an antiseptic lotion. Where the posterior or anterior wall of the vagina is much prolapsed, a wedge-shaped piece of mucous membrane may be removed, and the edges of the incision brought together by suture.

INJURIES OF THE SCROTUM AND TESTICLE.—Wounds of the scrotum and penis are rare. They readily heal in consequence of their abundant blood-supply. Contused wounds of the scrotum are often attended with much extravasation of blood, giving the parts a black and swollen appearance, and are apt to be followed by sloughing. Should such threaten, free incisions must be made. Extravasation of blood into the tunica vaginalis (*hæmatocele*), and inflammation of the testicle (*orchitis*), both of which may follow a blow or other injury of the parts, are described under *Diseases of the Testicle.*

FRACTURE AND DISLOCATION OF THE PENIS are of very rare occurrence.

LIGATURE OF THE PENIS.—A piece of string is sometimes tied round the penis by children either in play, or to prevent themselves wetting the bed. Great swelling in front of the constriction ensues, and if the cause is not recognized and removed, the string will soon cut deeply into the penis, and may even divide the urethra.

FOREIGN BODIES IN THE MALE URETHRA AND BLADDER.—Pieces of slate-pencil, beads, and the like, are sometimes passed by boys or the insane into their urethra, and not infrequently a piece of wax bougie, or damaged gum-elastic or black catheter, is broken off during catheterization. An attempt should be made to remove the foreign body by manipulation with the fingers, or by the introduction of various urethral forceps, or by asking the patient to first close the meatus with the finger and thumb, to make a forcible attempt to pass water, and then suddenly to let go. If the forceps are used the urethra should be grasped, if practicable, behind the foreign body, lest it be pushed back into the bladder. These means failing, it may be pushed back into the bladder, broken up by a lithotrite, and washed out by the evacuator, or, if soft, grasped with the lithotrite and extracted whole. I have frequently removed a piece of soft catheter in this way. If it cannot be pushed into the bladder, it must be cut down upon and extracted through an incision in the middle line of the urethra. A pin introduced head first should have the point thrust out through the skin up to the head. The head can thus be reversed, and may so be pushed out through the meatus. If a *foreign body* is allowed to remain in the urethra it becomes encrusted with phosphates, and gives rise to symptoms of impacted calculus (which see). Foreign bodies in the bladder soon become encrusted with phosphates and cause symptoms of stone (see *Stone in the Urethraa and Bladder*).

INJURIES OF THE UPPER EXTREMITY.

BRUISES, CONTUSIONS, BURNS, SCALDS, AND FROSTBITES of the upper extremity require no special remarks.

SPRAINS of the joints of the upper extremity, especially of the wrist, are very common. Rest, the application of cold, and in the case of the thumb, wrist, or elbow, a wet bandage followed by massage and friction with a stimulating liniment, is the usual treatment. A sprain, however slight, should never be neglected, as inflammation in or around the joint may ensue, leading to fibrous ankylosis, adhesion of the tendons to their sheaths, &c. See *Sprains*, p. 117.

SPRAINS OF THE MUSCLES, causing tenderness, slight swelling, and pain on movement, are not infrequently met with after hard rowing or other excessive exercise.

RUPTURE OF MUSCLES AND TENDONS, especially the pectoralis major, the rectus femoris, and the long tendon of the biceps, are not uncommon accidents. The last may occur during any sudden involuntary action, and may be known by sudden pain, loss of power, and a gap in the course of the long tendon, whilst the inner head, on putting the muscle into action, forms a prominent lump. Little or nothing can be done in the way of treatment.

WOUNDS of all kinds are very common. Wounds of the palm only need special comment.

WOUNDS OF THE PALM are frequently attended with severe and troublesome hæmorrhage from either the superficial or deep arch. When the wound is clean cut the bleeding vessel may be tied in the usual way; but when it is of a punctured character an Esmarch's bandage should be applied, and the wound having been carefully enlarged the vessel should be sought and both ends tied. If the dissection is neatly performed with strict antiseptic precautions much less harm, if any, will be done than was often caused by the now antiquated graduated compress. If the patient is not seen until the palm has become infiltrated and sloughy through the use of a compress, the brachial artery should be tied. The anastomosis through the interosseous and carpal arteries is so free that ligature of the radial and ulnar is not, as a rule, sufficient to stop the bleeding.

Needle in the palm.—It is not infrequent for a needle to run into the hand and be broken off. If it can be felt it should be cut down upon and extracted with forceps, care being taken not to push it in further, and so lose it in the attempt. If it cannot be felt, its situation should be determined by the *x* rays, and with the skiagraph in front of him, the surgeon should, avoiding important structures, expose the needle and remove it. An Esmarch's bandage, and of course the strictest antiseptic precautions, should be used.

In smashes of the hand requiring operative interference, the thumb and as many fingers—indeed as much of the hand—as possible, should be saved.

Dislocations of the Upper Extremity.

Dislocations of the clavicle.—I. The *sternal end* may be dislocated, 1, forwards; 2, upwards; and, 3, backwards. The forward variety is the most frequent; the upward is very rare. *Cause.*—The forward and the upward dislocations are produced by indirect violence, such as a blow or fall upon the *front* or *top* of the shoulder; the backward variety either directly by force applied to the sternal end, or indirectly by a blow or fall on the *back* of the shoulder. *Displacement.*—In the *forward* dislocation the end of the bone lies in front of the sternum, in the *upward* it lies in the suprasternal notch touching the opposite clavicle, in the *backward* between the sternum and the trachea. *Signs.*—In the forward dislocation (Fig. 166) the end of the bone can be felt in its abnormal situation, and can be distinguished from fracture near the sternal end by the length of the clavicle being the same on the two sides, and by the absence of crepitus. The upward variety, which is very rare, may be diagnosed in the same way. In the backward, which is also rare, there is a depression at the situation of the sterno-clavicular joint, and there may be dyspnœa, dysphagia, or congestion of the head and face from pressure on the trachea, œsophagus, or veins of the neck. *Treatment.*—The forward and the backward dislocations can generally be readily reduced by simply drawing back the shoulders, the knee, if necessary, being placed between the scapulæ. In the forward variety, indeed, I have always found the end of the clavicle sink into its place on laying the patient on his back. Reduction of the backward variety has at times been mpossible, and excision of the end of the bone has been necessary or the relief of the severe dyspnœa which it has caused by its ressure on the trachea. The upward dislocation may be reduced y placing a pad in the axilla to act as a fulcrum and pressing the rm to the side, thus drawing the clavicle outwards. Direct presure should at the same time be applied to the displaced end. All forms are difficult to retain in position. The best plan, perhaps, is to keep the patient constantly on his back for three weeks. If, however, he will not consent to this restraint, an endeavour may be made to retain the parts in as good a position as possible by one of the many methods of bandaging described in the special works on fracture. I do not mention any here, as I have never seen or found any of them of any avail.

II. The *acromial end* may be dislocated either, 1, upwards; or, 2, downwards. Both forms are rare, but the upward is the least so. The injuries are sometimes spoken of as dislocations of the scapula. *Cause.*—Commonly direct violence applied to the acromion. The *signs* are usually obvious. There is apparent lengthening of the arm with depression and slight flattening of the shoulder, and a projection in the region of the acromio-clavicular joint caused, in the *upward* form, by the acromial end of the clavicle, and in the *downward* by the acromion process. In the upward variety moreover the end of the trapezius stands out as a prominent ridge, and on pressing with one hand on the shoulder and with the other on the elbow the articular surfaces are brought into apposition and pseudo-crepitus can be obtained. *Reduction* is as a rule easily effected by drawing the shoulders well backwards; but it is difficult to retain the bones in position in consequence of the peculiar obliquity of the articulation. This may be attempted by placing a pad over the joint and applying a strap or a bandage over the shoulder and under the elbow, and then bandaging the arm to the side. I have seen the best results from rest in the horizontal position for three weeks; few patients, however, will submit to this, nor is it possibly worth their while to do so, as little inconvenience attends the dislocation, though unreduced.

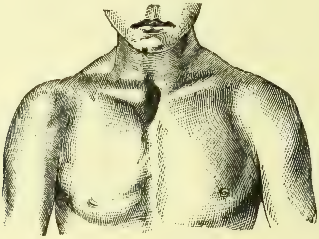


FIG. 166.—Dislocation of the sternal end of the clavicle forwards. (Bryant's Surgery.)

DISLOCATION OF THE SHOULDER is very common, a fact explained by the shallowness of the glenoid cavity, the large size and rounded shape of the head of the bone, the looseness of the capsule, and the powerful leverage exerted on the joint by the arm in protecting the body in falls, &c. It is most frequent in the old and middle-aged, rare in the young, and more common in men than in women.

Cause.—Falls on the elbow or hand with the arm abducted; forcible twists of the arm; falls or blows directly upon the shoulder; and occasionally muscular action.

Varieties.—Dislocations of the shoulder may be classified according to the position of the head of the humerus into—1, forward and slightly downwards (*subcoracoid*); 2, downwards and slightly forwards (*subglenoid*); 3, backwards (*subspinous*); and 4, forwards and inwards (*subclavicular*) (Figs. 167, 168, 169, and 170). An upward dislocation (*subacromial*) has been described, but this form of displacement is more generally believed to be the result of chronic osteo-arthritis. Other and rarer varieties have also been described, but appear to be merely modifications of those above enumerated.

The *signs* common to all the varieties in addition to the ordinary signs of dislocation, viz., pain, swelling, immobility, and absence of crepitus, are—1, flattening of the shoulder; 2, prominence of the acromion; 3, a depression beneath the acromion, increased when the arm is raised; 4, a change in direction of the axis of the humerus; 5, the absence of the head of the bone from the glenoid cavity, and its presence in an abnormal situation; and 6, alteration in the length of the limb when compared with that of the opposite side. In doubtful cases the following tests will be found of use:—1, *Hamilton's test.* A straight edge applied to the outer side of the arm, can only be made to touch the acromion and external condyle at the same time when the head of the humerus is absent from the glenoid cavity; 2, *Callaway's test.* A tape passed round the acromion and under the axilla will measure about two inches more on the dislocated than on the sound side; 3, *Dugas's test.* With the hand placed on the opposite shoulder, the elbow in a dislocation cannot be made to touch the chest; 4, *Humphry's test.* If the great tuberosity of the humerus can be felt beneath and a little external to the acromion, the head is in the glenoid cavity. Occasionally a dislocation is complicated by a fracture, and an accurate diagnosis may be rendered very difficult. In such, and in all cases where there is any doubt, the position and condition of the head of bone should be ascertained by the x rays, and a further examination, if necessary, should be subsequently made under an anæsthetic.

The subcoracoid.—This is the most frequent variety of dislocation of the shoulder (Fig. 167). The head rests on the anterior surface of the neck of the scapula, just below the coracoid process, the groove between the head and greater tuberosity resting on the anterior margin of the glenoid cavity. The capsular ligament is lacerated, anteriorly and inferiorly, or detached from the margin of the glenoid cavity in front and below. The subscapularis is generally raised by the head of the bone from the scapula, and the supraspinatus, infraspinatus, and teres minor are tightly stretched.

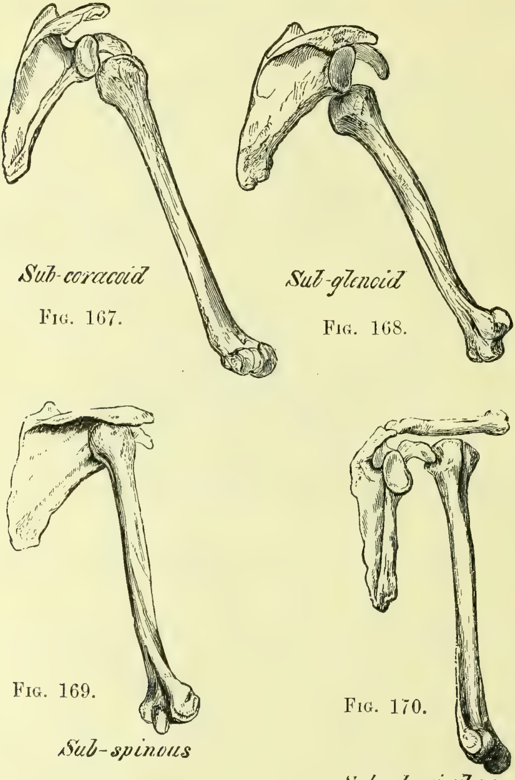


Fig. 167.

Fig. 168.

Fig. 169.

Fig. 170.

Figs. 167, 168, 169, 170.—Various forms of dislocation of the humerus. (Professor Flower's models.)

Sometimes the muscles are torn across at their insertion, or the greater tuberosity is detached, the muscles remaining entire. Under these circumstances the head of the bone rolls inwards so that more of it is internal to the coracoid process, a condition described by Malgaigne as a distinct variety (*intracoracoid*). The long head of the biceps is generally uninjured, whilst the short head and the coraco-brachialis and the axillary artery and brachial plexus are displaced inwards by the head of the bone. *Special signs.*—1, The head of the bone can be seen and felt in its abnormal situation; 2, the elbow projects slightly backwards and away from the side; 3, the arm is generally shortened or unaltered in length; occasionally it is said to be lengthened. The truth appears to be that there are all grades between the subcoracoid as here described, in which there is undoubted shortening, and the next form, the subglenoid, in which lengthening as undoubtedly occurs.

The *subglenoid* is the next most common variety. The head rests on the inner aspect of the inferior border of the scapula, below and a little in front of the glenoid cavity (Fig. 168). The capsular ligament is ruptured below. The supraspinatus, infraspinatus, teres minor, and subscapularis may or may not be torn. The circumflex nerve is especially liable to be compressed, producing temporary or even permanent paralysis of the deltoid. The signs are similar to those of the subcoracoid, but there is greater flattening of the shoulder, more prominence of the acromion, and a more marked depression under it, and the elbow points neither backwards nor forwards, but is carried away from the side. *Special signs.*—1, Great depression of the anterior fold of the axilla; 2, presence of the head of the bone in the axilla; 3, lengthening of the arm; 4, an interval of from one to two inches between the coracoid process and the head of the bone. A very rare variety of the subglenoid dislocation, in which the arm is not only abducted but raised so that the elbow is on a level with the head, is known as *luxatio erecta*.

The subspinous.—This variety is rare. The head rests on the dorsum of the scapula beneath the spine (Fig. 169). The capsular ligament may or may not be ruptured. The infraspinatus is generally torn up from the bone, and the subscapularis and supraspinatus are either stretched, or ruptured, according to the amount of displacement. The teres minor is relaxed, and the long tendon of the biceps stretched or displaced from its groove. *Special signs.*—1, Great flattening of the shoulder, with deep hollow below the coracoid; 2, slight lengthening of the arm; 3, the elbow points forwards; 4, the forearm is in front of the chest in consequence of the inward rotation of the humerus, which is close to the side; 5, the head of the bone can be felt in its abnormal situation, but not in the axilla.

The subclavicular is very rare. The head rests beneath the clavicle, internal to the coracoid process (Fig. 170). The capsule is generally extensively lacerated at its inner side. The pectoral muscles are raised by the head of the bone, which rests on the ribs either on or between the fibres of the subscapularis. The latter muscle is torn up from the subscapular fossa, but retains its connection to the humerus. The supraspinatus and infraspinatus are generally torn, or detached from the humerus, but may retain their connection to the capsular ligament. The teres minor is not torn. *Special signs.*—1. The head of the bone forms a distinct prominence below the clavicle; 2, the shaft only can be felt in the axilla; 3, the arm is pressed tightly to the chest; and 4, the elbow projects backwards.

Diagnosis.—A dislocation of the shoulder may have to be diagnosed from a fracture of the neck of the humerus, separation of the upper epiphysis, fracture of the neck of the scapula, fracture of the glenoid cavity, and from simple sprains and contusions of the joint attended with more or less paralysis of the deltoid. Attention to the general and special signs of dislocation as above given, together with the absence of crepitus and other signs of fracture, will generally make the diagnosis easy; but where the patient is very muscular, or there is much swelling, or manipulation causes excessive pain, a skiagraph should be first taken, and if this is not quite satisfactory, a thorough examination should be made under an anæsthetic. It should not be forgotten that crepitus may be simulated by effusion into the joint and sheaths of the surrounding tendons. True bony crepitus having been once felt, however, can hardly be mistaken for this.

Treatment.—The difficulty in reducing a recent dislocation consists in—1. Overcoming muscular contraction; and 2. Re-introducing the head of the bone through the hole in the capsule. In long-standing cases there are additional impediments to reduction, viz., 3. The formation of adhesions around the joint. 4. Alteration in the shape of the head of the bone; and 5. The obliteration of the old cavity. Manipulation should first be tried, if necessary, under an anæsthetic, and if this fails, extension should be made with the knee or heel in the axilla, and finally with the pulleys. In some long-standing cases where the above methods have failed reduction by open incision, rather than the use of excessive force, may be advisable. 1. *Manipulation.*—Many methods have been devised, some of which are not unattended with danger, as the axillary artery has been torn or ruptured in their use. The following method (Kocher's) is now generally employed at St. Bartholomew's, and has been attended with excellent success. Place the patient in the horizontal position; flex the elbow; abduct the humerus and rotate it outwards as far as possible without using excessive force, then carry the elbow across the chest, keeping up the eversion, and finally rotate the humerus inwards. Another method consists in slowly abducting the arm to the level of the shoulder or above. 2. *Extension* (Fig. 171).—Place the patient on his back; seat yourself on the edge of the couch; draw the arm slightly from the side; place your heel without your boot well in the axilla, and grasping the wrist, make steady extension on the arm, whilst the heel fixes the scapula and presses the head of the bone outwards. The head of the bone will probably be felt after a few minutes to slip into its place with an audible snap. Should it not do so, secure a jack towel with a clove-hitch (Fig. 172) to the arm, and increase the extending force by getting an assistant to pull on it at the same time. The direction of the force may be slightly varied from time to time, and the humerus gently rotated. Where extension with the heel in the axilla fails, slowly carry the arm to a right angle with the body and extend, or raise it above the head, and again extend in this position. If still unsuccessful an anæsthetic should be given, and the bone, on again trying manipulation or extension, will probably slip back quite easily into place. 3. *Extension with the pulleys.*—In long-standing cases the use of the pulleys may be required. First break down any adhesions that may be present, by cautiously manipulating the arm; then fix the scapula by a well-padded leather strap passed under the axilla and secured to a staple in the wall. Attach the pulleys to a leather band buckled round the arm, and make steady extension, manipulating the head of the bone the while. The extension and counter-extension should always be made in the same horizontal line. This may be first in the direction of the axis of the body, then across he body, with the arm at right angles to it (Fig. 173). Occasionally

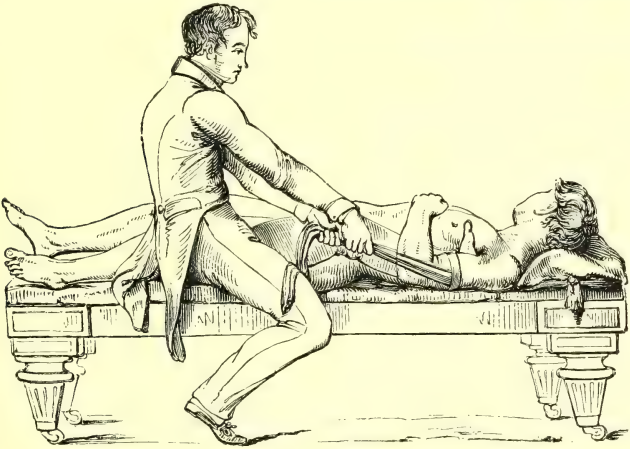


Fig. 171.—Reduction by the heel in the axilla. (Cooper's Dislocations.)

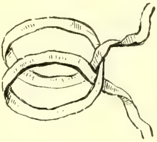


Fig. 172.—The clove-hitch.

success may be obtained by suddenly relaxing the extension after it has been applied for a few minutes, endeavouring at the same moment to manipulate the head into its place. Although the direction of the force appears to vary in the different methods of extension, it is probable that in consequence of the mobility of the scapula, it is nearly always applied perpendicularly to the plane of the glenoid cavity.

After-treatment.—A pad should be placed in the axilla and the arm carefully bandaged to the side with the fore-arm across the chest, and the hand on the opposite shoulder. Passive movements of the joint should be begun about the end of a week and practised once or twice daily; but the arm should be bandaged to the chest in the intervals for upwards of three weeks, and subsequently used with great caution for several months to prevent re-dislocation.

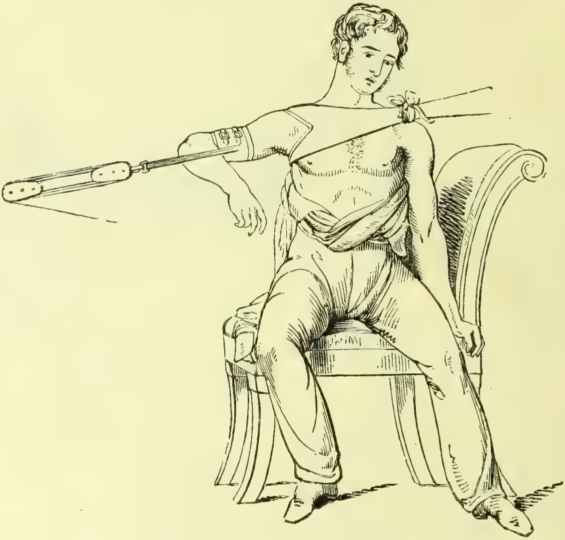


Fig. 173.—Reduction with the pulleys. The patient, though here shown sitting, should as a rule be placed in the recumbent posture, as an anæsthetic is generally required. (Cooper's Dislocations.)

Occasional ill-effects following a dislocation of the shoulder.—1. Inflammation or suppuration of the joint and ankylosis; 2. Paralysis of the deltoid or other muscles; 3. Axillary abscess; 4. Non-union of the rent in the capsule and a consequent tendency to re-dislocation on very slight violence.

How long after a dislocation of the shoulder has occurred does it *admit of reduction?* Sir Astley Cooper fixed the limit at three months, but cases are reported in which it is said to have been accomplished two years after the accident. It should be remembered, however, that as in unreduced dislocations a new cavity is gradually formed for the head of the bone whilst the old cavity is filled up, reduction sooner or later becomes a physical impossibility. Still, where the arm is very stiff, although reduction may not be accomplished, the range of motion in the false joint may be considerably improved by the attempt. On the other hand, where the motion is fairly free, the injury inflicted in an attempt at reduction may counterbalance any advantage gained.

Risks that may attend reduction in long-standing cases.—1. Rupture of the axillary artery or vein; 2. Injury of the brachial plexus of nerves; 3. Fracture of the neck of the humerus; 4. Fracture of the ribs; 5. Tearing open of the axilla; 6. Evulsion of the arm; and 7. Fatal shock in the old and feeble.

4. *Reduction by open incision.*—This method has been recently employed for long-standing cases where cautious attempts at reduction by manipulation and extension have failed. The advantages claimed for it are:—1. That the reduction can be accomplished without subjecting the patient to the dangers mentioned above, and 2. That it is applicable at periods later than those at which reduction by manipulation or by extension can be accomplished without undue risk. An incision is made down to the head of the bone between the pectoralis major and deltoid muscles, and the subscapularis muscle detached from its insertion into the lesser tuberosity. The long head of the biceps should be preserved as in excision of the joint. If the bone cannot now be manipulated or prised by an elevator into position the attachments of the external rotators (the supraspinatus, infraspinatus and teres minor) are in like manner detached from the greater tuberosity. The head will now probably return into its socket unless the time that has elapsed has been sufficient for it to have been partly absorbed and the glenoid cavity filled up. When, however, the head cannot be replaced it may be excised. Passive movements ought to be begun as soon as the wound has healed.

Treatment of compound dislocation of the shoulder.—When the wound is small, the head of the bone uninjured, and the soft parts are neither much lacerated nor bruised, an attempt should be made to reduce the dislocation. If successful, the case may then be treated as a wound of the joint. When the head of the bone is much injured, it may be excised; whilst in severe and complicated cases, amputation at the shoulder-joint may become necessary.

The treatment of dislocation with fracture is often attended with much difficulty. As a rule the fracture if possible should be set, the arm placed in splints, and an attempt then made to reduce the dislocation. Failing in this, the separated head may sometimes be manipulated into its socket; otherwise, splints should be applied. It is often advised that another trial be made to reduce the dislocation after the fracture has united, but this is more likely to re-fracture the neck than reduce the head. McBurney has succeeded in replacing the head by means of a strong hook inserted into a hole drilled in the upper fragment exposed by open incision.

Treatment of recurrent dislocation.—When the humerus constantly slips out of its socket on the least muscular exertion, in consequence probably of a large unhealed rent in the capsule or separation of the rotators from the tuberosities, an excision of the head of the bone holds out the best prospect of relief.

DISLOCATION OF THE ELBOW is most frequent in the young. *Cause.*—Direct violence, or a fall on, or wrench of, the forearm or hand. *Varieties.*—A. *Both bones* (radius and ulna): 1, backwards; 2, inward ; 3, outwards; 4, forwards; and 5, radius forwards, and ulna backwards. B. *Radius only:* 1, forwards; 2, backwards; and 3, outwards. C. *Ulna only:* 1, backwards. Of these, the dislocation of both bones backwards and of the radius forwards or backwards are the only common forms; the others are very rare, and will receive but a passing notice.

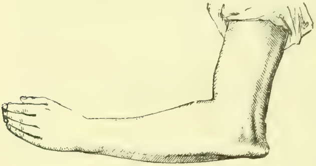


FIG. 174.—Dislocation of the radius and ulna backwards. (Cooper's Dislocations.)

Signs.—In the common form of *both bones backwards* (Fig. 174), the radius and ulna are displaced directly backwards, so that the coronoid process of the ulna rests in the olecranon fossa, and the neck of the radius on the capitellum of the humerus. The coronoid process is often fractured at the same time. The anterior, and often the lateral ligaments are torn, and the brachialis anticus is tense or partly lacerated. The bones are frequently displaced slightly outwards, or inwards, as well as backwards—modifications which have been unnecessarily classed as distinct varieties. The forearm is fixed, partially flexed, and shortened. The olecranon and head of the radius form an unnatural prominence posteriorly, and are felt at a considerable distance behind the internal and external condyles respectively. The lower end of the humerus forms a broad projection *below* the crease of the bend of the elbow. In the rarer forms of *both bones inwards* or *outwards* the prominence of the opposite condyle of the humerus on one or other side is a characteristic feature. In *both bones forwards* (exceedingly rare) the forearm is lengthened, the natural prominence of the olecranon is lost, and the condyles of the humerus are very prominent. In the *ulna backwards and the radius forwards* the arm is greatly increased in its antero-posterior diameter.

In dislocation of the radius alone, whether forwards, backwards, or outwards, the head of the bone is felt to roll in its abnormal situation, in front of, behind, or external to, the external condyle on pronating and supinating the hand. The first of these forms (Fig. 175) is the most common, and in it the forearm cannot be flexed beyond a right angle, in consequence of the head of the bone striking the humerus.

In dislocation of the ulna backwards the forearm is pronated and shortened on the ulnar side, and the olecranon projects backwards, but the head of the radius is felt in its normal situation.

Diagnosis.—In moderately thin subjects when seen soon after the accident, attention to the above signs will generally enable the surgeon to make a diagnosis; but in a few hours the parts become so obscured by swelling about the joint, that it may be impossible to make out the nature of the injury till it has subsided, except by the x rays or examination under an anæsthetic. In all cases of injury of the elbow the relation of the points of bone to each other should be carefully compared with those of the uninjured side, and the relative position of the olecranon to the condyles should be determined (see *Fracture of the lower end of the Humerus*).

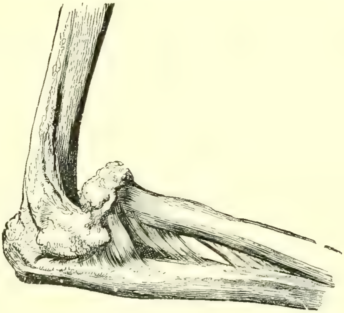


Fig. 175.—Dislocation of the radius forwards.

Treatment.—The reduction of the common form of dislocation of *both bones backwards* is generally easily accomplished in recent cases by pressing with the knee in the bend of the elbow on the upper part of the radius and ulna to disengage the coronoid process, whilst forcibly but slowly flexing the forearm. As soon as the coronoid process is freed from the olecranon fossa, the muscles generally draw the bones suddenly into position. Pressure upon the humerus by the knee, as recommended by some, should be avoided, as it locks the coronoid process more tightly in the olecranon fossa. If necessary, an anæsthetic should be given. In long-standing cases adhesions should be cautiously broken down by forcibly flexing and extending the forearm, and extension may then be made either by the knee, or by an assistant pulling on the wrist. Six weeks is the period usually given as the time beyond which it is inexpedient to try and reduce the dislocation. This rule, however, admits of some latitude. Thus, an attempt at reduction, when the movement is fairly good, even after less time has elapsed, may be unwise; while, on the other hand, it may sometimes be made with advantage, especially where there is much rigidity, even at a later period. Too great force, however, is to be deprecated, as irreparable damage may be done. A better result may be obtained by open incision or resection of the joint. In dislocation of the *radius alone*, extension should be made from the hand (so as to act solely on the radius), whilst the elbow-joint is grasped, and the head of the radius pressed into position by the thumb in a backward or forward or inward direction, according to the variety of the dislocation. In the other dislocations slight modifications of these methods are required, and will be suggested by a knowledge of the anatomy of the joint, and a correct diagnosis of the nature of the displacement.

After-treatment.—The joint should be placed on an inside angular splint and the arm in a sling, and evaporating lotions or ice applied to prevent inflammation. Passive movements should be cautiously begun about ten days or a fortnight after the injury.

Complications.—1, Fracture of (*a*) the coronoid process; (*b*) the olecranon; (*c*) the neck of the radius; (*d*) the lower end of the humerus; and (*e*) the condyles of the humerus; 2, Separation of the lower epiphysis of the humerus; 3, Wound of the joint; 4, Laceration of the main artery; and 5, Injury of the ulnar or other nerve.

Treatment of compound dislocation of the elbow.—When the patient is young, the wound small, the laceration and bruising of the soft parts but slight, and the bones are uninjured, the dislocation should be reduced, and the case treated as a wound of the joint. Otherwise excision of the joint, or in severe cases amputation, must be practised.

Dislocation of the wrist is very rare. The carpus with the hand may be displaced either backwards or forwards. In the dislocation backwards, which is the more common variety, the carpus forms a projection on the dorsal surface of the wrist, whilst the ends of the radius and ulna project on the palmar surface. It resembles Colles' fracture, which was formerly confused with it. In the dislocation the styloid processes of the radius and ulna are on the normal level, and are nearer the knuckles than is natural, and there is no crepitus. *Treatment.*—Reduction is easily effected by making extension on the hand and pressing upon the displaced bones. The forearm and hand should then be secured to a splint, and passive movements begun early to prevent stiffness.

Dislocation of the lower end of the radius from the ulna may be produced by a violent twist of the hand. When the twist is in the direction of pronation, the radius is displaced forwards when of supination, backwards. The former is the more common. The hand accompanies the radius, and the styloid process of the ulna projects prominently in the opposite direction and has been sometimes forced through the skin. *Treatment.*—Whilst making extension from the hand, manipulate the bone into position and retain it there by a compress and splint.

DISLOCATIONS OF THE CARPAL AND METACARPAL BONES are very rare. Their diagnosis is usually obvious.

The *phalanges of the fingers* may be dislocated backwards or forwards. Reduction is easily effected by extension and manipulation.

Dislocation of the metacarpal bone of the thumb from the trapezium may occur in a backward or forward direction, and is easily reduced by extension or pressure.

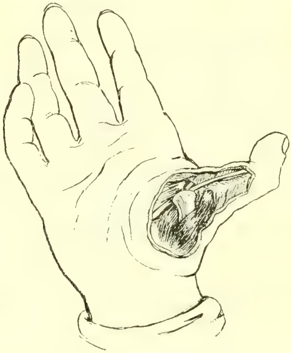


FIG. 176.—Dislocation of the thumb backwards at the metacarpo-phalangeal joint. (After Agnew.)

Dislocation of the first phalanx of the thumb from the metacarpal bone is of more importance. The phalanx is nearly always displaced backwards; the shortening of the thumb and the projections of the base of the phalanx and head of the metacarpal bone serve for its diagnosis. Reduction is often very difficult; this is usually ascribed to the head of the metacarpal bone being forced between the two insertions of the flexor brevis pollicis by which its neck is tightly embraced (Fig. 176). Sir George Humphry, however, has shown that the hindrance to reduction depends upon the fact that the sesamoid bones and the ligaments connecting them are carried back with the phalanx, and, being held there by the flexor brevis and intervening between the metacarpal bone and the phalanx, prevent the articular surfaces of the bones being brought into contact. *Treatment.*—Press the metacarpal bone well into the palm of the hand to relax the flexor brevis pollicis, and bend back the first phalanx on the metacarpal bone until the extremity of the thumb points towards the wrist, thus forcing the base of the phalanx wedge-wise between the two insertions of the short flexor. Next flex the phalanx while an assistant, by placing his thumb behind its base, prevents it slipping back. The head of the metacarpal bone will now probably slide into its place between the two insertions of the flexor brevis pollicis, which are forced apart by the wedge-like action of the base of the phalanx. Reduction may sometimes be accomplished by extension, *e.g.*, by the clove-hitch, or if, at hand, by the Indian puzzle-toy or the American forceps—a method, however, less scientific than that of manipulation, and one which seldom succeeds if the other fails. These means not proving successful, it is usually advised that the insertion of the flexor brevis pollicis should be subcutaneously divided. Sir George Humphry, however, recommended an incision over the sesamoid bones and the introduction of a hook to hitch the sesamoid bones over the head of the metacarpal. In this way, he says, the reduction is immediately effected. As a last resource, the joint may be cut down upon, the bands resisting reduction divided and the bone replaced, or the joint may be excised, or perhaps better, left alone, as very fair movement will, as a rule, in time be gained.

Fractures of the Upper Extremity.

Fractures of the clavicle are divided into fractures of—1, the *shaft;* 2, the *acromial end;* and 3, the *sternal end.*

I. *The Shaft* may be fractured by direct violence, or, as is more commonly the case, by indirect violence, such as a fall upon the arm or shoulder; more rarely by muscular action. *Situations.*—When the result of indirect violence or muscular action, the bone is generally broken near its centre—its weakest part. When due to direct violence, the bone will break wherever the force is applied. *Nature of the displacement.*—The inner fragment, although it appears raised in consequence of the depression of the outer, is not displaced, being held in position by the sterno-mastoid and the rhomboid ligament; the outer fragment is drawn downwards, forwards and inwards by the weight of the arm and the contraction of the pectoral muscles. The *signs* in an adult are usually very evident. The inner fragment projects prominently under the skin; the shoulder droops forwards and downwards; the patient usually supports his elbow with the sound hand whilst he inclines his head to the fractured side to relax the sterno-mastoid. In a fat child, however, especially when the fracture is of the greenstick variety (Fig. 177), which it often is in children, the signs are less evident; indeed surgical aid is often not sought until the mother's attention is called to the part by the presence of a lump formed by the ensheathing callus. Union generally occurs in about three weeks in children and five in adults. *Treatment.*—The fracture is easily reduced by drawing back the shoulders, or by placing the patient in the recumbent posture; but it is very difficult to maintain the fragments in apposition. Hence the numerous bandages and apparatus that have been from time to time employed. Where it is important to avoid deformity, rest on the back for a fortnight is essential; otherwise the patient may be allowed to get about with his arm bandaged to the side, and the parts kept as much as possible in apposition by bandaging or strapping. Of the many plans the following may be tried.

a. Sayre's method.—Take three pieces of adhesive strapping about three inches and a half wide, and long enough to surround the arm and afterwards the body. Stitch one piece, with the adhesive surface outside, loosely round the arm on the injured side at the insertion of the deltoid muscle. Draw the arm forcibly backwards to put the clavicular portion of the pectoralis major on the stretch, and carry the strapping across the back and round the front of the thorax and sew the end to the part which crosses the back (Fig. 178). Fix one end of the second strip of plaster to the sound shoulder; carry it obliquely across the back beneath the elbow (which should be pushed forwards) of the injured side, a slit being made to receive the olecranon; bring it upwards in front of the chest, and fasten it to its other end over the sound shoulder (Figs. 179 and 180). A third strip may be carried round the arm, forearm and thorax to keep the others in place. The first strip acts as a fulcrum; whilst the second, by drawing the elbow forwards forces the upper end of the humerus, with the clavicle, backwards, and at the same time keeps the shoulder raised. *b. Ellis's method* consists briefly in the use of an axillary crutch supported by two straps, the one round the chest, the other passed over the sound shoulder. The chest strap also encircles the arm and holds it firmly to the side. The forearm is further supported by a sling. *c. The axillary pad and bandage.*—Many surgeons simply place a wedge-shaped pad with the base upwards in the axilla, and then bandage the arm to the side with the elbow well raised. If the pad is used, care should be taken in bandaging lest the axillary vessels or nerves are compressed, and œedma, pain, or even gangrene of the arm be the consequence.

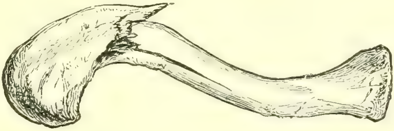


FIG. 177.—Greenstick fracture of the clavicle. (Holmes' System.)

II. *Fracture of the acromial end of the clavicle* may occur either at or external to the insertion of the coraco-clavicular ligaments. In the former situation there is very little displacement, the fragments being held in position by the above-mentioned ligaments. Pain, crepitus, and possibly a slight gap, will serve to distinguish it. When external to the ligaments the outer fragment is drawn down nearly at a right angle to the rest of the bone, so that its acromial articulation looks inwards, forwards, and slightly downwards. *Treatment.*—An axillary pad and bandage, with a moulded leather shoulder-cap to protect the parts.

III. *Fracture of the sternal end* and separation of the sternal epiphysis are very rare.

THE SCAPULA.—The fracture may extend through 1, the body; 2, the acromion; 3, the coracoid process; 4, the neck; and 5, the glenoid cavity.

1. *Fracture of the body* is nearly always caused by direct violence. It may be star-shaped or transverse, or it may run vertically or obliquely through the spine; but commonly it is limited to the infraspinous fossa, and frequently the angle is alone broken off. The displacement is not usually very marked, as the fragments are well covered with muscles. *Signs.*—On fixing the angle of the scapula with one hand, and raising the arm, crepitus and pain may be elicited. On running the fingers along the spine and down the posterior border, some irregularity may be detected when these parts are involved, and on grasping the bone the fragments may be felt to move on each other. *Treatment.*—Little can be done beyond confining the scapula by strapping and a bandage to the chest, and restraining the motions of the arm by bandaging it to the side.

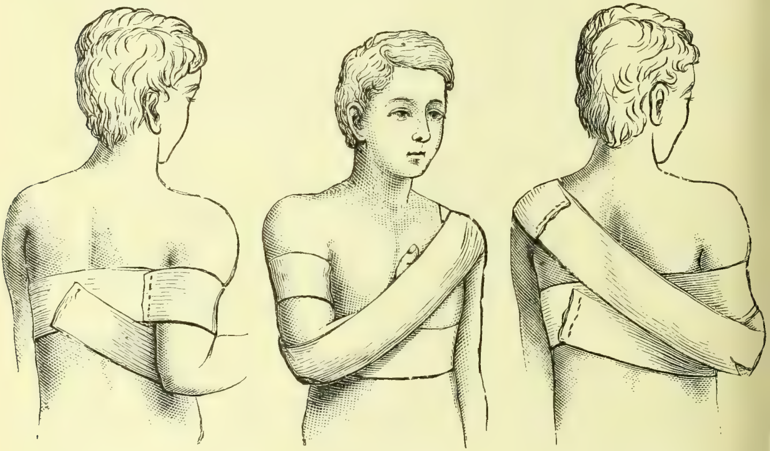


FIG. 178. FIG. 179. FIG. 180.

FIGS. 178, 179, 180.—Sayre's method of treating fractured clavicle. (After Agnew.)

2. *Fracture of the acromion* may occur at any situation. *Cause.*—Direct violence, such as a blow or a fall on the shoulder. *Nature of the displacement.*—The outer fragment is drawn downwards by the deltoid, leaving a gap between it and the rest of the bone. *Symptoms.*—Pain, flattening of the shoulder, presence of a gap on drawing the finger along the spine, acromion and clavicle; and crepitus on raising the arm and thus bringing the fragments into apposition. *Union.*—When near the tip the union is fibrous; when near the base, it is said to be bony. *Treatment.*—Raise the elbow so as to relax the deltoid, and fix the arm to the side by a sling and bandage, protecting the parts by a gutta-percha cap moulded to the shoulder. Some employ an axilla-pad.

3. *Fracture of the coracoid process* is very rare, but may occur either near the tip or near the root. The cause is usually direct violence, such as a kick or a fall on the shoulder. *Nature of the displacement.*—When the fracture is near the tip the distal fragment is drawn downwards by the biceps; when near the root it is held in position by the coraco-clavicular ligaments, and but little displacement occurs. *Signs.*—Bruising and pain over the situation of the coracoid. On placing the finger on the tip of the coracoid some alteration in its relative position may be made out, and crepitus elicited by moving the arm. *Treatment.*—The forearm should be flexed to relax the biceps; the arm and forearm bandaged to the side; and a cap of gutta-percha placed over the shoulder.

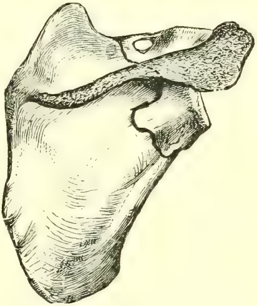


Fig. 181.—Fracture of the neck of the scapula. (Guy's Hospital Museum.)

4. *Fracture of the neck.*—By this is understood fracture through the surgical neck, *i.e.*, internal to the coracoid, so that the latter process is separated with the glenoid cavity from the rest of the bone. There is a specimen of it in the Hunterian and in Guy's Hospital Museum (Fig. 181), though it is stated by some not to occur. The *signs* which have been ascribed to this injury resemble those of dislocation of the humerus downwards. The deformity, however, is said to disappear on pressing up the elbow, when crepitus can be elicited, and to reappear on removing the pressure. The *treatment* recommended is to raise the elbow, and maintain the parts in their restored position by a bandage.

5. *Fracture of the glenoid cavity* is also rare. At times it occurs in connection with dislocation of the shoulder.

The humerus.—Fractures of the humerus are divided into fractures of 1, the upper end; 2, the shaft; and 3, the lower end.

1. THE UPPER END OF THE HUMERUS.—*Varieties.*—A. Intracapsular, or fracture of the anatomical neck. B. Extracapsular, or fracture of the surgical neck. C. Separation of the upper epiphysis. D. Fracture of the greater tuberosity.

A. *The intracapsular fracture* may be impacted or non-impacted. When *non-impacted* the head may remain loose in the capsule, being rotated in various directions or even turned so that its articular surface is in contact with the shaft, or it may be dislocated downwards and inwards through a rent in the capsule into the axilla. When *impacted* the upper fragment, or head, is commonly driven into the lower, that is, between the tuberosities. *Cause.*—Generally direct violence, as a blow or fall on the shoulder. *Signs.*—Often obscure. There may be pain, swelling, impaired movement, and crepitus, with absence of signs of dislocation or of other fracture about the shoulder. In the *impacted* variety there is generally some prominence of the acromion; loss of rotundity of the shoulder; slight shortening of the arm; and inability to feel the whole of the head in the glenoid cavity; crepitus is not as a rule present, though it may sometimes be elicited by firmly grasping the head and rotating the shaft. *Method of union.*—Fibrous or bony, often with excess of callus and impairment of movement of the joint. *Treatment.*—Apply a leather or poroplastic shield to the shoulder and outer side of the arm, rectifying any displacement inwards by a pad in the axilla. Bandage the arm from the fingers upwards to prevent swelling, and confine it to the side of the chest without raising the elbow. When the fracture is impacted do not disturb the fragments. Passive movements and massage should be begun early (in about three weeks). Some surgeons employ massage from the first. If the head is dislocated an attempt may be made to replace it, or it may be excised after a few days if it cannot be replaced, or if replaced interferes with free movement.

B. *The extracapsular fracture* is the most common form of fracture about the shoulder. It may, like the intracapsular variety, be impacted or non-impacted; but when impaction occurs it is the lower fragment that is driven into the upper, *i.e.*, the narrower shaft between the broader tuberosities. *Cause.*—Generally direct violence. *Nature of the displacement.*—The upper fragment is rotated outwards by the three muscles inserted into the greater tuberosity; the lower fragment is drawn upwards by the deltoid and inwards by the three muscles inserted into the bicipital ridges (Fig. 182). *Signs.*—Pain, swelling, and impaired movement; marked shortening of the arm; projection of the rough end of the lower fragment, usually below the coracoid; and increased mobility of the arm to the surgeon. On rotating the arm, the head remains motionless in the glenoid cavity, whilst on extension crepitus is felt. In the *impacted* form the signs are very obscure, and principally negative. Thus, there may be deformity, slight shortening, and impaired movement; but there is no crepitus, unless unjustifiable force is used. *Union* is generally bony. There is often much impairment of movement, in consequence of inflammatory thickening, and sometimes paralysis of the deltoid, from the involvement of the circumflex nerve in the callus. *Treatment.*—Similar to the intracapsular form. Place a pad in the axilla, and a poroplastic shield over the shoulder and outer side of the arm. Support the hand in a sling, but do not raise the elbow, in order that the weight of the arm may act as an extending force to overcome the upward displacement.

C. *Separation of the upper epiphysis* can only occur in patients under twenty-one years of age. *Nature of the displacement.*—The upper fragment, which includes the tuberosities, is drawn outwards by the three muscles inserted into the greater tuberosity, and the lower fragment upwards by the deltoid, and inwards by the three muscles inserted into the bicipital ridges. The *signs* are similar to those of the extracapsular fracture, save that the projecting end of the lower fragment is smooth and rounded in place of being rough and uneven, and pseudo-crepitus, instead of bony crepitus, is elicited on extension and rotation of the rm. *Method of union.*—Usually bony, but with much less production of callus, and consequently less impairment of movement than in other fractures of the upper end. *Treatment.*—Like that of racture of the surgical neck.

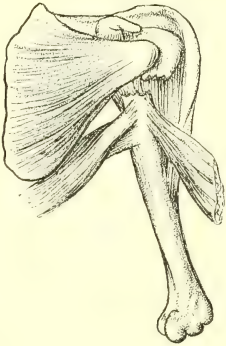


FIG. 182.—Extracapsular fracture of the humerus. (After Gray.)

D. *Fracture through the greater tuberosity* is the result of great iolence, and is very rare. *Nature of the displacement.*—The humerus s drawn inwards beneath the coracoid process by the muscles nserted into the bicipital ridges, and the greater tuberosity backvards by the three muscles inserted into it. *Signs.*—The shoulder s greatly increased in breadth; a vertical gap may, perhaps, be ade out between the tuberosity and the head of the bone; and on pproximating the fragments, crepitus can be felt. *Treatment.*—ndeavour to bring the fragments into contact and to keep them by an axillary pad, strapping and bandage; apply a shield over e shoulder, and confine the arm to the side.

The diagnosis of fracture from other injuries about the shoulder often attended with great difficulty. In all cases in which there the slightest doubt, a skiagraph should be taken and an examinaon under an anæsthetic made.

2. THE SHAFT OF THE HUMERUS may be fractured in any situation, but more often in its lower than in its upper half. *Causes.*—Direct or indirect violence, rarely muscular action. *Nature of the displacement.*—When the line of fracture is transverse little displacement occurs; but when it is oblique, the fragments have a tendency to glide over one another owing to muscular action, although this is somewhat counteracted by the weight of the arm. When the fracture is above the insertion of the deltoid the upper fragment is drawn inwards by the muscles inserted into the bicipital ridges; whilst the lower fragment is drawn upwards by the biceps and triceps, and outwards by the deltoid. When below the deltoid, the upper fragment is drawn outwards by that muscle and the lower fragment upwards and inwards by the biceps and triceps. *Signs.*—Usually obvious, viz., pain, preternatural mobility, and generally deformity and shortening; whilst crepitus is readily obtained. *Method of union.*—Generally bony; but it is one of the most common situations of ununited fracture. *Treatment.*—Place the arm and forearm on an inside rectangular splint with three short splints to the humerus, one in front, one behind, and one on the outer side. Or, apply four short splints to the humerus and support the forearm by a sling, leaving the elbow free, so that the weight of the arm may act as an extending force. The splints should be worn from a month to five or six weeks. The fingers and forearm may often with advantage be bandaged to prevent œdema.

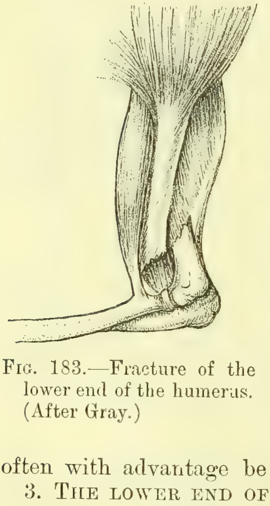


FIG. 183.—Fracture of the lower end of the humerus. (After Gray.)

3. THE LOWER END OF THE HUMERUS.—Fractures in this situation may be divided into (*a*) transverse fracture; (*b*) separation of the epiphysis; (*c*) T-shaped fracture; (*d*) fracture of the condyles. Of these, the transverse when above the condyles, the separation of the epiphysis, and the fracture of the tip of the internal condyle, are *extracapsular;* the others involve the joint. *Cause.*—All varieties are generally the result of direct violence, such as falls upon the bent elbow.

(*a*) *The transverse fracture* may be above or below the condyles; in the former case it is extra-, in the latter intracapsular. *Nature of the displacement.*—The lower fragment, together with the bones of the forearm, are drawn backwards and upwards behind the upper fragment by the triceps, whilst the lower end of the upper fragment projects in front of the joint (Fig. 183). *Signs.*—The forearm is shortened and generally bent more or less at a right angle to the arm; the olecranon projects posteriorly; and the lower end of the upper fragment forms a prominence in front of the joint. The signs are similar to those of dislocation of the radius and ulna backwards. The following differences presented by the two injuries should serve to distinguish them; although when not seen immediately after the accident the condition of the parts may be so obscured by swelling that an accurate diagnosis cannot be made till the inflammation has subsided. Thus, in *fracture*—1, the deformity is really reduced, but reappears on removing the extending force; 2, crepitus is obtained on reduction; 3, the condyles bear normal relations to the olecranon; 4, the distance between the acromion and external condyle is less than on the sound side; 5, the prominent lower end of the upper fragment projects *above* the crease at the front of the elbow. In *dislocation*, on the other hand—1, the deformity does not reappear when reduced; 2, there is no crepitus; 3, the distance between the condyles and olecranon is increased; 4, the distance between the acromion and external condyle is the same on both sides; and 5, the prominent lower end of the humerus projects *below* the crease at the front of the elbow. In this fracture, however, as in all other fractures and injuries about the elbow, much aid in the diagnosis will be obtained by the use of the x rays and an examination under an anæsthetic.

(*b*) *Separation of the epiphysis.*—The signs are similar to the above, but the patient is under twenty-one years of age.

(*c*) *T-shaped fracture.*—In this there is a transverse fracture above the condyles, combined with a vertical or oblique fracture extending between the condyles into the joint. *Signs.*—Similar to the transverse fracture, except that the condyles move on one another as well as on the shaft, and the distance between them is increased. These signs, however, are often obscured by great effusion in and around the joint.

(*d*) *Fracture of the condyles.*—The projecting internal condyle may be broken off without implicating the joint; or the fracture may extend obliquely through either condyle and the contiguous articular surface into the joint. *Cause.*—Generally direct violence. *Signs.*—Mobility and crepitus on grasping the condyles, and on flexing and extending the forearm when the internal condyle is fractured, and on pronating and supinating the hand when the external condyle is fractured.

Method of union.—The extracapsular varieties unite by bone, the intracapsular by fibrous tissue. In the T-shaped fracture the transverse portion unites by bone; the vertical or oblique, *i.e.*, the portion inside the joint, by fibrous tissue.

Treatment.—If there is much swelling, and you cannot be quite sure that there is no dislocation, place the limb on a pillow, or better, on a Stromeyer's cushion, and apply cold in the form of lead lotion or ice, till the swelling has subsided. Subsequently reduce the fracture, and place the arm and forearm on an angular splint or on a bent anterior splint, or in Bavarian plaster, moulded leather, or poroplastic felt splints. Passive movements of the elbow should be begun early whenever the fracture involves the joint, but when it is transverse above the joint they should be delayed for a month, since there is then no danger of a stiff joint, but a risk of the passive movements at the seat of fracture leading to a false joint. Where the internal condyle only is chipped off, the angular splint should be placed on the outer side of the arm. In the other forms it is usually applied to the inner side.

THE RADIUS AND ULNA. *Cause.*—Generally direct violence, when each bone breaks in the same transverse line at the spot where the force is applied; occasionally indirect violence, as a fall on the hand, when each bone generally breaks at its weakest part —the radius in its upper third, the ulna in its lower third. *Nature of the displacement.*—The upper fragment of the radius is drawn by the pronator teres towards the upper fragment of the ulna, which in consequence of its hinge-shaped articulation with the humerus is not displaced. The lower fragments are drawn towards each other by the pronator quadratus. *Signs.*—Obvious deformity, crepitus, &c. *Treatment.*—Flex the elbow to relax the muscles; reduce the fracture, and place the forearm in well-padded splints with the thumb uppermost. In this position the bones are midway between pronation and supination, and parallel to one another. There is, consequently, a good interval between them, and the danger of the radius becoming united by callus to the ulna, as in Fig. 55, is avoided. During pronation the radius crosses the ulna. Were the fracture set with the bones thus in contact, the risk of their uniting would be great. The splints should reach from above the elbow to below the wrist, and should be broader than the forearm so that the bones may not be pressed together by the bandage. If this point is attended to, interosseous pads are not necessary. The patient should be seen within twenty-four hours, as swelling may occur and the bandages require loosening. The splints must be worn for about a month, and passive movements of the fingers practised early to prevent stiffening.

Greenstick fracture of the radius and ulna is common in children.

THE RADIUS.—Fractures of the radius may involve, 1, the neck; 2, the shaft; and, 3, the lower end (Colles' fracture).

1. *The neck of the radius* is occasionally fractured. It may be known by crepitus, and by the absence of movement of the head when the hand is pronated and supinated. *Treatment.*—Flex the forearm, and place the limb on an angular splint.

2. *The shaft of the radius* may be fractured by direct or indirect

violence. Both fragments are drawn towards the ulna, the upper by the pronator teres, the lower by the pronator quadratus (Fig. 184). *Treatment.*—Similar to that of fracture of both bones.

3. *Fracture of the lower end of the radius* (*Colles' fracture*).—The line of fracture generally runs transversely about three-quarters of an inch above the articular surface of the bone. *Cause.*—Falls on the palm of the hand. It is more frequent in the old than in the young; and is especially common in elderly women. *Nature of the displacement.*—Sometimes there may be no displacement, but generally the lower fragment with the hand is so displaced that the articular surface looks downwards, and slightly backwards and outwards, instead of downwards, forwards and inwards. This, according to Mr. R. W. Smith, is due to the action of the supinator longus, the extensors of the thumb, and the radial extensors of the carpus. By others it is believed to be due to the impaction of the upper fragment into the lower, a condition frequently met with in specimens preserved in museums. Occasionally the lower fragment is displaced forwards in consequence of falls on the back of the hand. Comminution of the lower fragment with involvement of the wrist-joint frequently occurs. *Signs.*—Very haracteristic. On the back of the wrist, just above the joint, there s a prominence caused by the backvardly displaced lower fragment, nd above this a slight depression; whilst on the palmar surface here is a prominence caused by the lower end of the upper fragment, orresponding to the dorsal depression, and below this a depression orresponding to the dorsal prominence. Pronation and supination re lost, the hand is deflected to the radial side, and the lower end f the ulna is prominent. The deformity is well seen in Fig. 185. hese signs are similar to those of dislocation of the carpus backards. The following points will serve to distinguish the two ijuries:—In *fracture*, 1, the styloid process of the radius is on a igher plane than that of the ulna; 2, the distance from the iternal condyle to the tip of the styloid process of the radius is

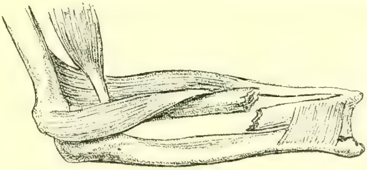


FIG. 184.—Fracture of the radius. (After Gray.)

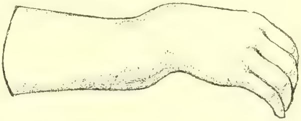


FIG. 185.—Colles' fracture. (St. Bartholomew's Hospital Museum.)

less than on the sound side; 3, there is crepitus; 4, the deformity, when it can be reduced, has a tendency to return if the extending force is relaxed; and 5, it is very common in the old, and occurs from slight causes. In *dislocation*, on the other hand, 1, the styloid process of the radius is on a lower plane than that of the ulna; 2, the distance from the internal condyle to the tip of the styloid process of the radius is the same as on the sound side; 3, there is no crepitus; 4, the deformity when reduced has no tendency to return when the extending force is relaxed; and, 5, it is usually the result of great violence, and more frequently occurs in the young than in the old. *Treatment.*—After reducing the fracture as thoroughly as possible apply two ordinary forearm splints, taking care that the anterior one does not reach beyond the heads of the metacarpal bones, and place a pad beneath the wrist to restore the lost concavity of the front of the radius. Practise passive movements from the third day, as in this form of fracture the tendons, where they cross the back of the radius, the seat of fracture, are apt to become adherent to their grooves. This is the almost invariable method of treating Colles' fracture at St. Bartholomew's Hospital, and is attended with excellent results. If preferred, Gordon's (Fig. 187), Carr's, Hawkins', or Bond's splints may be used. After the splints are applied a skiagraph should be taken to make sure that the fracture has been properly reduced. The pistol-shaped splint introduced by Nélaton, and justly condemned by Sir James Paget as so frequent a cause of stiff wrist and fingers should on no account be used. Remove the splints in three or four weeks, and employ shampooing, friction with stimulating liniments, &c., till any stiffness of the joint or fingers that remains has disappeared.

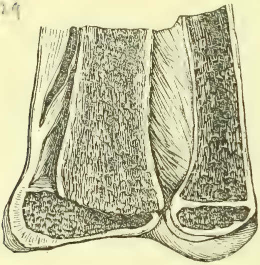


Fig. 186.—Separation of the lower epiphysis of the radius from a lad aged 16 years. (St. Bartholomew's Hospital Museum, No. 758*b*.)

Separation of the lower epiphysis (Fig. 186) may occur in young subjects, and resembles Colles' fracture.

THE ULNA.—Fractures of the ulna may be divided into fracture of—1, the olecranon; 2, the coronoid process; and 3, the shaft.

1. *The olecranon* may be fractured in a transverse or oblique direction. The elbow-joint is always involved, except when the fracture is through the tip of the process only. *Cause.*—Direct violence, as a fall on the point of the elbow, or violent action of the triceps muscle. *Nature of the displacement* (Fig. 188).—The detached fragment is usually widely separated from the rest of the

bone by the triceps; but when the periosteum and tendinous expansion of the triceps covering the olecranon is not torn, and the fracture is very oblique, little or no displacement occurs. *Signs.*—Swelling from effusion of blood, and later of serum, into the joint inability of the patient as a rule to extend his arm; and generally, the presence of a gap between the fragments. *Method of union.*—Usually fibrous; but when the separation of the fragments is slight, it may be bony. *Treatment.*—Place the elbow in a position of *slight* flexion on a jointed splint, and apply evaporating lotions till the swelling has subsided. An attempt may be made to bring down the detached fragments by strapping and a bandage. Passive movements should be begun early to prevent ankylosis (seventh day, Hamilton). Many advise that the arm should be put up in full extension; but this is objectionable, as it causes the olecranon to form an angle with the shaft. Mr. Heath on the other hand strongly recommends flexion of the arm to a right angle. Some surgeons wire the fragments.

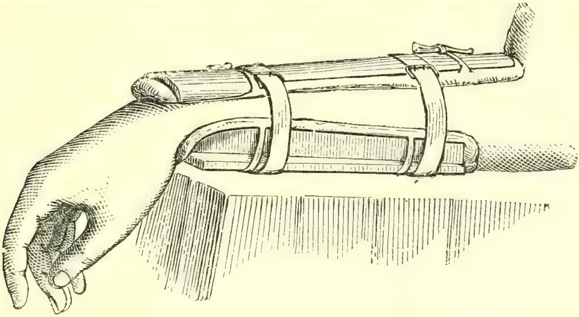


Fig. 187.—Gordon's splint for Colles' fracture. (Gordon's Fractures.)

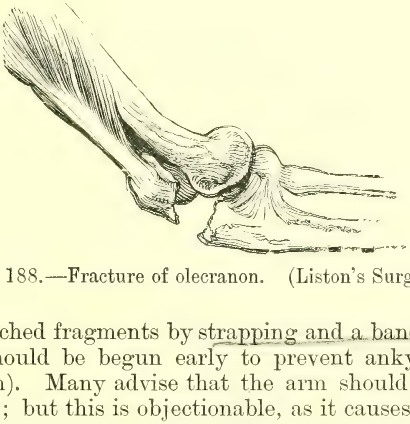


Fig. 188.—Fracture of olecranon. (Liston's Surgery.)

2. *The coronoid process of the ulna*, except in dislocation of the ulna and radius backwards, is rarely fractured. It is said at times to occur from violent contraction of the brachialis anticus muscle. *Signs.*—When fracture of the coronoid is present in dislocation of the radius and ulna backwards, the dislocation is readily reduced, but immediately returns on relaxing the extending force. When fracture of the coronoid is not present, the dislocation is more difficult to reduce; but when once reduced, has no tendency to recur. *Treatment.*—After reducing the dislocation, place the arm in a flexed position on an inside angular splint. Employ passive movements early.

3. *The shaft of the ulna* is occasionally fractured without implication of the radius. *Cause.*—Direct violence. *Nature of the displacement.*—The upper fragment is not displaced, being held in position by its hinge-shaped articulation with the humerus. The lower fragment is drawn towards the radius by the pronator quadratus. *Signs.*—It is readily detected by running the finger along the prominent posterior border of the bone, when a gap or irregularity is felt, and by crepitus on movement. *Treatment.*—Similar to that of fracture of the radius.

The carpus, metacarpus and phalanges.—Fractures of these bones require no special mention. They may be diagnosed by the deformity and crepitus. Rest for a few weeks on a splint, followed by passive movements to prevent stiffness, is all that is generally necessary.

INJURIES OF THE LOWER EXTREMITY.

Bruises or contusions, burns, scalds, and frost-bites of the lower extremity call for no special mention beyond that bruises about the hip and ankle may be mistaken for fracture, and that a contusion of the limb may be so severe at times as to terminate in gangrene.

Sprains of the ankle and knee are very common. Pain, inability to bear any weight on the limb, effusion into the joint or the sheaths of the surrounding tendons, and later, ecchymosis of the skin, are the usual signs. A sprain of the ankle, when there is much swelling, is often difficult, and sometimes impossible, to diagnose from a fracture, and should then be treated as such. For an ordinary sprain absolute rest should be enjoined, and cold or evaporating lotions or a wet bandage should be applied. When the swelling has subsided, the part may be put in a plaster-of-Paris bandage or in a poroplastic splint for some weeks, and then shampooing and passive movements employed if any stiffness be left. Some surgeons advise massage from the first.

Rupture of muscles and tendons, either as the result of external violence or of sudden and spasmodic contraction of the muscle, is not infrequent in the lower limbs. Here, only rupture of the plantaris or Achilles tendon requires special notice. It usually happens in men beyond the middle period of life without any evident cause. It is attended with a distinct snap, and a feeling as if the part had been struck, followed by pain, and sometimes by ecchymosis, and by inability to raise the heel. *Treatment.*—A plaster-of-Paris bandage should be applied with the foot in the extended position to approximate the ends of the ruptured tendon. If a heel is made to the plaster case, the patient need not lay up. The plaster case should be worn for two or three weeks.

Dislocations of the Lower Extremity.

DISLOCATION OF THE HIP.—This injury is much less common than dislocation of the shoulder, a fact readily explained by the strength of the capsular ligament, the depth of the acetabulum, and the powerful muscles by which the joint is surrounded. It occurs, however, more frequently than might be expected, owing to the powerful leverage which, from the great strength of the femur and length of the leg, is brought to bear upon the joint in falls upon the knee and foot with the limb extended and abducted. Dislocation, therefore, as might be inferred, is more common in the young and strong; fracture of the neck of the femur in the old and feeble. *Cause.*—Dislocation of the hip, whatever form it may take, generally occurs when the limb is abducted. In this position the head of the bone presses upon the inner and lower part of the capsule, its weakest part, and if any sudden or great force is now applied to the other end of the lever, the head of the bone may be forced through the capsule at this spot into the obturator foramen. Here it may remain, or if at the time of the accident the limb is flexed and rotated inwards as well as abducted, it may be carried round the outer margin of the acetabulum on to the dorsum ilii; or, if the limb is extended and rotated outwards as well as abducted, round the inner margin on to the pubes. In rare instances, it would appear to occur during forced adduction of the limb, the head of the bone being then driven directly backwards on to the dorsum ilii. In such a case, however, the rim of the acetabulum is generally, though not always, splintered off at the same time.

The Y, *or ilio-femoral ligament* plays so important a part in dislocation of the hip that its attachments should be briefly considered before studying the varieties of this dislocation. It consists of a thickening of the front of the capsular ligament, and is attached above to the anterior inferior spine of the ilium, and then divides into two branches like the letter Y inverted. The outer branch is inserted into the upper part of the anterior inter-trochanteric ridge; the inner branch into the lower part of that ridge. It is exceedingly strong, and will bear a breaking strain of from 250 to 750 pounds. Both branches limit extension; the outer branch rotation outwards as well. The whole ligament therefore is tense during extension and outward rotation of the limb; relaxed during flexion and rotation inwards.

Varieties.—Dislocations of the hip are divided by Bigelow into the *regular*, in which one or both branches of the **Y** ligament are intact, and the *irregular*, in which both branches are ruptured. In the former the signs are constant, as the untorn branch of the **Y** ligament compels the bone to take a certain definite position. In the irregular the signs vary, as both branches of the **Y** being ruptured, the control which it exercises over the position of the bone is lost. Our attention here will only be directed to the regular dislocations. Of these Bigelow describes seven, the first four of which are commonly known as the *classical dislocations of Sir Astley Cooper.*

Cooper's Classification.		Bigelow's Classification.	
		A. Regular. *One or both branches of* **Y** *entire.*	
Dislocation on to the dorsum ilii	=	1. Dorsal	Both branches of **Y** entire.
Dislocation into the sciatic notch	=	2. Dorsal below the tendon	
Dislocation into the obturator foramen	=	3. Thyroid and downwards	
Dislocation on to the pubes	=	4. Pubic and subspinous	
		5. Anterior oblique	
		6. Supraspinous	Outer branch of **Y** ruptured.
		7. Everted dorsal	
		B. Irregular. *Both branches of* **Y** *ruptured.*	

1. *Dislocation on to the dorsum ilii (the dorsal of Bigelow).*—This is the most common form of dislocation of the hip. The head of the bone is thrown upwards and backwards on to the dorsum of the ilium, the articular surface of the head looking backwards, and the great trochanter forwards. The capsular ligament is generally ruptured at its lower and inner part, sometimes posteriorly, and the round ligament is usually torn. The **Y** ligament is uninjured,

the external branch preventing eversion. The glutei muscles are raised from the ilium by the head of the bone, which is always situated above the tendon of the obturator internus. The other external rotators have been found variously lacerated or torn from their attachments. *Signs* (Fig. 189).—The limb is slightly flexed, adducted, rotated inwards, and shortened, so that the lower end of the femur crosses the lower third of the opposite thigh, and the great toe rests on the instep of the opposite foot. The head of the bone, at least in thin subjects, can be felt in its abnormal situation on rotating the limb. The great trochanter is above a line drawn from the anterior superior iliac spine to the most prominent part of the tuberosity of the ischium (*Nélaton's line*) (Fig. 191); and the distance from the top of the great trochanter to a line drawn horizontally round the pelvis on a level with the anterior superior iliac spines (*Bryant's line*) is less on the injured than on the sound side.

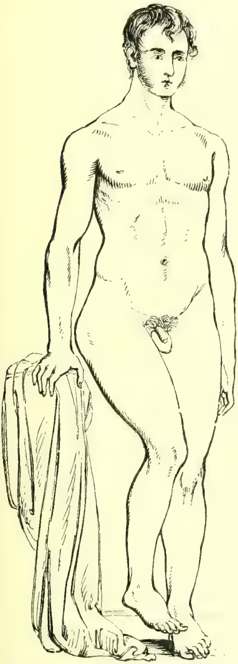


Fig. 189.—Dislocation on dorsum ilii.

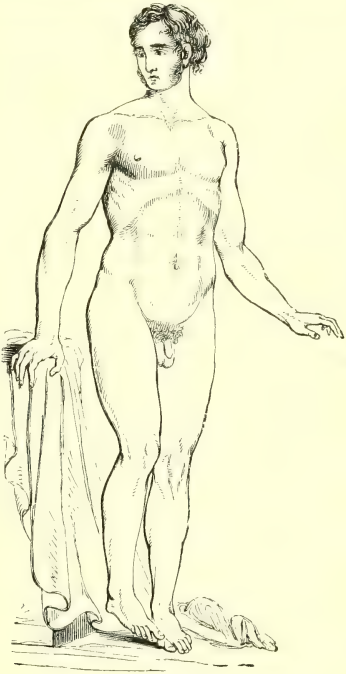


Fig. 190.—Dislocation into sciatic notch.

(Cooper's Dislocations.)

2. *Dislocation into the sciatic notch (the dorsal below the tendon of Bigelow).*—The head of the bone escapes below the tendon of the obturator internus, and then ascends behind it on to the surface of the ilium just in front of the sciatic notch, or on the pyriformis as it emerges from the notch. The head looks backwards and the great trochanter forwards, eversion being prevented by the outer branch of the Y ligament. The tendon of the obturator internus winds over the neck of the femur, and is therefore the

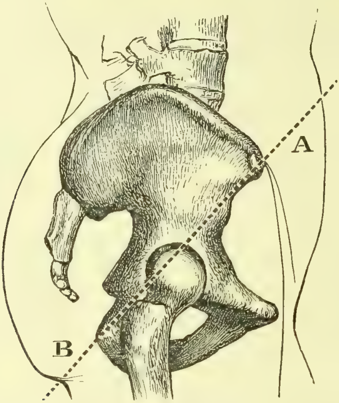


Fig. 191.—A—B, Nélaton's line.

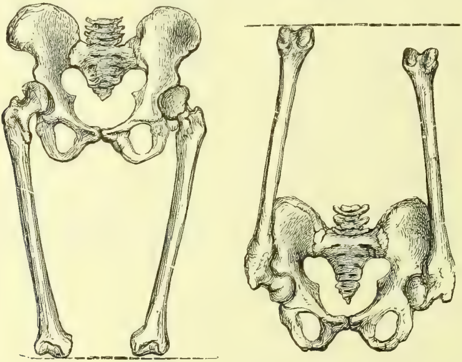


Fig. 192.—Sciatic dislocation of the left hip. *a*, shows slight shortening in extended position of limb ; *b*, shows marked shortening in flexed position. (After Dawson, of Ohio.)

great obstacle to reduction. The capsule is generally torn below, the round ligament ruptured, the gluteus maximus raised by the head of the bone, and one or more of the external rotators are usually torn. The *Signs* (Fig. 190) are very similar to those of the former variety; but the flexion, adduction, and rotation inwards are less pronounced. The lower end of the femur crosses the opposite knee, and the great toe rests on that of the opposite foot. Shortening with the limb extended is much less than in the former variety; but with the limb flexed it is much greater. This is shown in the accompanying diagram (Fig. 192), and depends upon the fact that in the dislocation on to the dorsum ilii the head of the bone in extension lies above the acetabulum, and when flexed at a right angle to the body on the same level as the acetabulum; whereas in the sciatic dislocation the head of the bone in extension

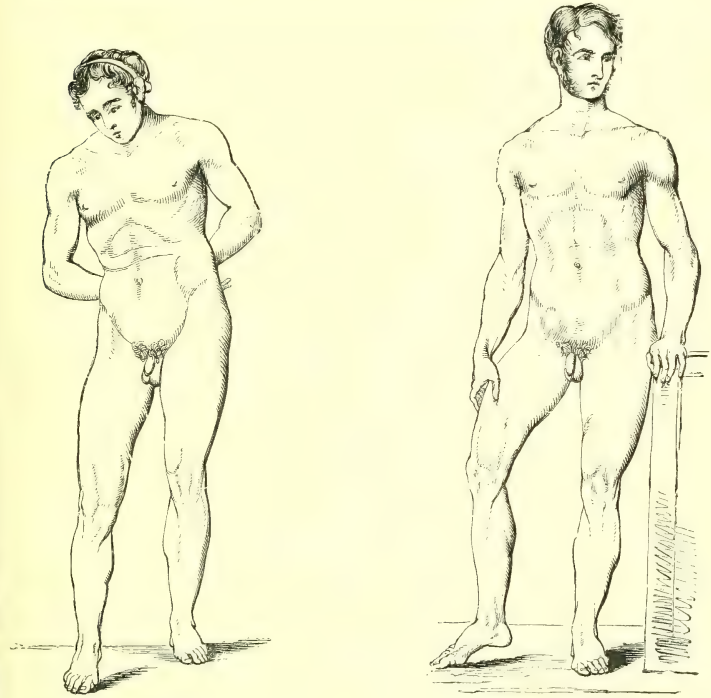


Fig. 193.—Dislocation into obturator foramen.

Fig. 194.—Dislocation on the pubes.

(Cooper's Dislocations.)

is almost on the same level as the acetabulum, but when flexed at a right angle to the body lies considerably behind the acetabulum.

3. *Dislocation into the obturator foramen* (*the thyroid and downwards of Bigelow*).—The head is displaced downwards on to the obturator externus, where its lies suspended by the Y ligament, and may remain either just below the acetabulum, or be carried slightly inwards towards the perineum or outwards towards the tuberosity of the ischium. The head of the bone generally looks slightly inwards, and the trochanter outwards. The capsule and round ligament are ruptured, the former at its lower and inner part. The glutei, pyriformis, psoas and iliacus, obturator externus, pectineus, and the adductor brevis are stretched or sometimes torn. *Signs* (Fig. 193).—In the more common form, viz., that in which the head is displaced downwards and a little inwards, the limb is apparently *lengthened*, due to the lowering of the pelvis on that side, but is really shortened about half an inch or so. It is also abducted and slightly flexed, whilst the body is bent forwards to relax the psoas and iliacus, and as there is usually some external rotation, the toes point slightly outwards. The nearer the head of the bone approaches the perineum the more plainly can it be felt, and the more eversion and abduction will there be; conversely, the nearer it approaches the tuberosity of the ischium the greater its inversion and adduction; whilst when it is displaced directly downwards there will be neither eversion nor inversion, adduction nor abduction, but marked flexion.

4. *Dislocation on to the pubes* (*the pubic and subspinous of Bigelow*).—The head of the bone is thrown forwards and rests below Poupart's ligament, either upon the ramus of the pubes (*pubic*) or upon the pectineal eminence just in front of the anterior inferior spine (*subspinous*). The head looks forwards and the trochanter backwards. The capsule is generally torn below, and the round ligament ruptured. The Y ligament is entire and produces the eversion of the limb characteristic of this variety. The psoas and iliacus, with the anterior crural nerve between them, are generally stretched tightly over the head of the bone. The femoral vessels are displaced to its inner side. *Signs* (Fig. 194).—The limb is slightly shortened, flexed, abducted, and rotated outwards; and the head of the bone can be plainly felt in its new situation. There is flattening over the hip-joint.

The *anterior oblique*, *supraspinous*, and *everted dorsal*, the three remaining regular dislocations of Bigelow, are too rare to be described here. They can readily be produced, however, on the dead body. Thus the ordinary dorsal dislocation can be converted into the *anterior oblique* by carrying the leg across the symphysis, forcibly everting the thigh, and bringing it down across the lower third of the opposite thigh, in which position it becomes firmly locked. If now the thigh is forced into the perpendicular position, the outer branch of the **Y** ligament will be ruptured and the *supraspinous* variety produced. This variety in its turn can be converted into the *everted dorsal* by circumducting the extended limb inwards and then everting it.

Treatment.—Reduction may be effected by: 1, manipulation; 2, traction with the limb in the flexed position; 3, traction with the limb in the extended position. Of these methods the first and the second are by far the most scientific, and when their principles are thoroughly understood and they are rightly applied, they are the most successful. Recent dislocations should always be reduced by the first or second method, aided if need be by an anæsthetic; and these methods will also often succeed in reducing cases of long standing after traction in the extended position, even with the pulleys, has failed. In long-standing cases, should the above-mentioned methods fail, reduction may under some circumstances be attempted by 4, open incision.

1. *Reduction by manipulation* consists in relaxing the **Y** ligament, the chief obstacle to reduction, and then by means of various movements of rotation, circumduction and extension applicable to each particular variety of dislocation, in making the head of the bone retrace its steps round the margin of the acetabulum, and finally re-enter the acetabulum through the hole in the capsule by which it escaped. To do this it is necessary to know in what direction the head of the bone looks in any particular position of the limb—a point easily determined by remembering that the articular surface of the head looks very nearly in the same direction as the internal condyle. It must be further remembered that by rotation is meant the rolling of the femur on its own axis; that in outward rotation the anterior surface of the patella is rolled outwards, and in inward rotation inwards; that by circumduction is meant the revolving of the femur round the axis of its head, and that in this movement the anterior surface of the patella always looks to the front. During the manipulation the patient should be placed upon his back on the floor, while the surgeon with one hand should grasp the ankle, and with the other the thigh or leg, and put the limb through the several movements required for the kind of dislocation. An assistant, if necessary, should fix the pelvis. For the dislocation on the *dorsum ilii* and into the *sciatic notch* the movements are practically the same (Fig. 195). The limb should be flexed and slightly adducted to disengage the head from behind the acetabulum and then abducted, rotated outwards and brought down parallel to the sound limb. These movements are tersely described by Bigelow in the words 'lift up,' 'bend out,' 'roll out,' *i.e.*, lift up or flex—bend out or abduct—roll out or rotate outwards. The head is thus compelled

Flex in adduction, abduct, [illegible]

to revolve round a centre formed by the great trochanter, which is held in position by the outer branch of the Y ligament. In the *thyroid* (Fig. 196) the thigh should be flexed and slightly abducted, then rotated forcibly inwards and adducted, and brought down parallel to the sound thigh. The head is thus made to retrace its steps towards, and re-enter the acetabulum, the Y ligament being wound up, as it were, and so put on the stretch. In the *pubic* the reduction is accomplished in a manner similar to that employed for the thyroid.

2. *Reduction by traction with the limb in the flexed position.*—The flexion of the limb has for its aim the relaxing of the Y ligament and other ligaments and tendons that impede reduction, and then drawing the head of the bone directly into its socket. In the *dorsal* dislocation the thigh should be flexed at a right angle to the body, and traction then made in an upward direction, slightly adducting and rotating inwards to disengage the head from behind the acetabulum. Counterpressure may be made, if necessary, by the surgeon placing his unbooted foot on the anterior iliac spine whilst drawing or jerking the limb upwards. If on flexion it is found that the limb cannot be abducted beyond the perpendicular with the body, the hole in the capsule is probably too small to allow of the head being replaced. It may readily be enlarged by circumducting the flexed thigh outwards across the abdomen. The pulleys may be used if more force is required, the patient then being laid on his sound side and counter-extension applied to the pelvis by a leather

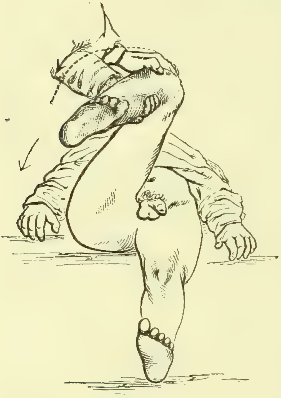


FIG. 195.—Method of reducing the dorsal and sciatic dislocations of the hip by manipulation.

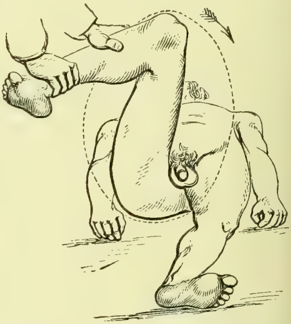


FIG. 196.—Method of reducing the pubic and thyroid dislocations of the hip by manipulation.

(After Bigelow.)

band secured to the wall; or the patient may be placed on his back, the pelvis secured to the floor, and the pulleys attached to a staple in the ceiling. In the *sciatic* the same method should be adopted, as the flexion frees the head of the bone from the tendon of the obturator internus which winds round its neck, and together with the **Y** ligament, which is also relaxed by flexion, is the chief obstacle to reduction. In the *thyroid* the limb should be flexed and abducted, and the head of the bone drawn towards the socket, counter-pressure being made, if required, by the unbooted foot on the pelvis. The pulleys may also be employed in this position if more force is required. In the *pubic* the limb should be flexed on the pelvis, whilst the head is drawn down towards the acetabulum by a jack-towel passed round the upper third of the thigh. At the same time the limb should be rotated slightly inwards.

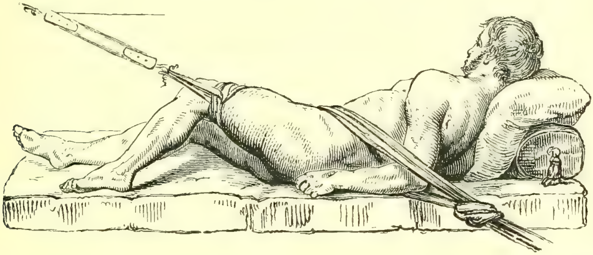


Fig. 197.—Reduction of dorsal dislocation by pulleys in extended position. (Cooper's Dislocations.)

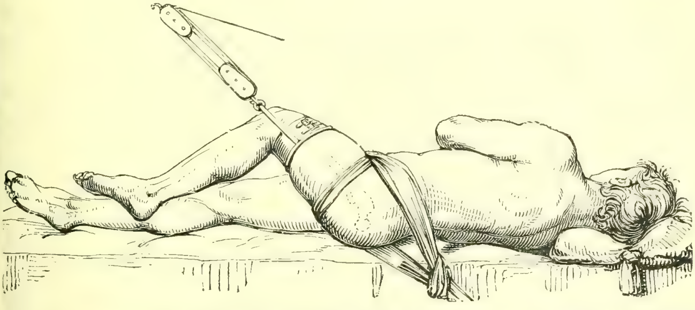


Fig. 198.—Reduction of sciatic dislocation by pulleys in extended position. (Cooper's Dislocations.)

3. *Reduction by traction with the limb in the extended position* is the method recommended by Sir Astley Cooper, but is one which is

now seldom used except in long-standing cases. It has for its object the drawing of the head of the femur directly into the acetabulum by main force, rupturing any ligaments, muscles, or tendons that offer impediment. The extending force is made in the line of the dislocated femur, generally by means of the pulleys, which are usually secured to the lower third of the thigh by a padded leather band, counter-extension being made simultaneously, and in the same straight line as the extension, by fixing the pelvis by means of a perineal band, secured by suitable straps to a staple in the wall or floor. The patient should be placed on a low couch or on a mattress on the floor. The line of extension and counter-extension differs according to the form of dislocation. Thus:—In the *dorsal* (Fig. 197), extension should be made across the lower third of the sound thigh, the pulleys being fixed to a staple in the wall a few feet from the foot of the couch above the level of the body, and the counter-extending band to a staple in the floor near the head of the couch. In the *sciatic* (Fig. 198), the extension is made in a nearly similar direction, save that the thigh should be more flexed. In the *thyroid* (Fig. 199), extension is made in an upward and outward direction, by means of a perineal band passed round the upper part of the dislocated thigh and attached to pulleys fixed to a staple in the wall on the injured side. Counter-extension is made by a band passed round the pelvis and secured to a staple in the floor on the sound side. The ankle, in the meantime, is drawn towards the mesial line of the body by the surgeon's hand passed behind the sound limb. The line of extension and counter-extension here runs obliquely across the body. In the *pubic* (Fig. 200), extension is made downwards and outwards by pulleys attached to a staple in the floor, counter-extension being made by the perineal band, which is carried upwards and inwards across the opposite shoulder, and attached to a staple in the wall.

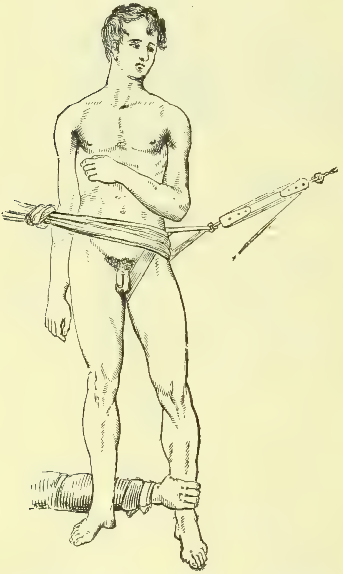


FIG. 199.—Reduction of thyroid dislocation by pulleys. (Cooper's Dislocations.)

After the extension has been applied some time the head of the bone may be lifted over the edge of the acetabulum by a jack-towel, the thigh, if necessary, being rotated inwards at the same time.

4. *Reduction by open incision* has of late been practised successfully in cases of long standing where manipulation and extension have failed. The head of the bone having been exposed it is freed from fibrous bands and adhesions, the acetabulum is cleared of any fibrous tissue that may be found filling it, and the head of the bone replaced.

THE PATELLA may be dislocated outwards, inwards, upwards, and edgeways. The outward dislocation is the most common; the upward variety can only occur when the ligamentum patellæ has been ruptured or divided. The outward and inward varieties may be complete or incomplete. In the dislocation edgeways, which is very rare, the patella rests vertically on one edge between the condyles, either the outer or the inner edge looking forwards, but most commonly the former. *Cause.*—Muscular action, or a blow on the outer or inner edge of the bone. Knock-knee predisposes to the outward dislocation. The *signs* are obvious, the position of the patella indicating the nature of the accident. *Treatment.*—With the patient anæsthetized, the thigh should be flexed on the abdomen, to relax the quadriceps extensor muscle; and the leg, for the same purpose, extended on the thigh. In the outward and inward dislocation, pressure should now be made on the edge of the patella that is further from the centre of the joint so as to raise the opposite edge and tilt it over the condyle, when it is at once drawn into place by the action of its muscles. In the edgeways variety, pressure should be made with the thumbs in opposite directions on the upper and lower margin of the dislocated bone, this manipulation being aided by suddenly and forcibly flexing the knee, and then, if necessary, by extending it. Reduction, though generally

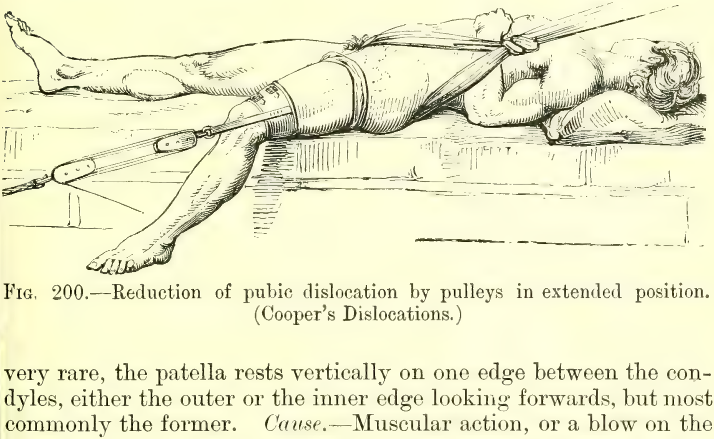


FIG. 200.—Reduction of pubic dislocation by pulleys in extended position. (Cooper's Dislocations.)

easy, is sometimes attended with great difficulty, and has occasionally been found impossible, even after subcutaneous division of ligaments and tendons. Effusion into the joint generally follows, and should be treated in the usual way. After reduction the joint should be placed on a back splint or in plaster-of-Paris, and a knee-cap subsequently worn to prevent a recurrence of the dislocation.

Partial dislocation of the patella, the result of an elongated patella ligament, sometimes occurs. The elongation of the ligament allows the patella to be placed on the femur when the knee is flexed so that its anterior surface looks directly upwards. As a consequence of the elongation of the ligament, the patella from time to time is apt to slip suddenly over one or other condyle, causing the patient to fall. In three cases I have succeeded in curing the condition by transplanting the tubercle of the tibia lower down the shaft of the bone, thus shortening the ligament half an inch to an inch according to the amount of elongation. The method of transplanting the tubercle will be understood by referring to Fig. 201. The tubercle was fixed in its new situation by an ivory peg.

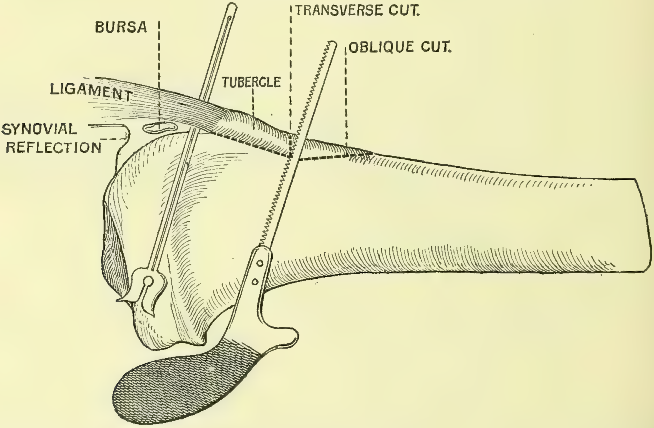


Fig. 201.—Author's method of transplanting the tubercle of the tibia for the purpose of shortening an elongated patella ligament.

THE KNEE.—Dislocation of the knee is exceedingly rare. It may occur in a forward, backward, inward, and outward direction, and in any case may be complete or incomplete. *Cause.*—Usually great violence, as a severe wrench or twist of the joint. *Signs.*—In the lateral dislocations, which are generally incomplete, a projection caused by the condyles of the femur on the one side, with a depression below, and a projection of the tibia, or of the fibula, as the case may be, on the opposite side, with a depression above, at once show the nature of the injury. In the antero-posterior varieties, which are generally complete, there is great shortening and deformity of the limb; the head of the tibia in the forward dislocation projects anteriorly; whilst in the backward it can be felt in the ham. In the former there is generally considerable swelling and congestion, and often pain in the limb below the knee, from pressure of the condyles of the femur on the popliteal vessels and nerves. *Treatment.*—Reduction, as a rule, is easily accomplished by extension, combined with manipulation and pressure in the direction indicated by the variety of the dislocation. The limb should then be placed on a back-splint, and an ice-bag applied to the knee, passive movements being begun at the end of two or three weeks, and a knee-cap subsequently worn for twelve months at the least. Compound dislocations usually, though not invariably, call for amputation.

Dislocation of one of the semilunar cartilages of the knee, usually the internal, may occur from a sudden twist or wrench of the joint during semi-flexion. The accident is attended with sudden and severe pain, a 'locking' of the joint usually in a bent position, and the presence of a hollow, sometimes of a projection over the site of the semilunar cartilage. There is at first commonly some effusion into the joint. In chronic cases the patient may be able to displace and replace the cartilage at will by twisting his knee. The condition may closely simulate a loose body in the joint or a nipped synovial fringe, but the above signs will generally suffice to distinguish it. The diagnosis is, however, sometimes difficult unless the patient is seen at the time the cartilage is displaced. *Treatment.*—To replace the cartilage, flex the thigh on the abdomen and the leg on the thigh, and rotate the leg outwards; then manipulate the cartilage with the fingers and suddenly extend the leg, at the same time rotating it outwards. To prevent a recurrence the movements of the joint should be limited to flexion and extension by means of a special form of splint (Fig. 202) which should be worn for a year or longer. In intractable

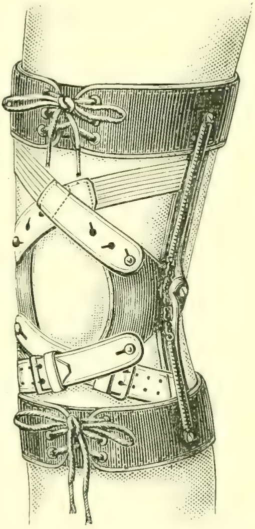


FIG. 202.—Splint for retaining in place a dislocated semilunar cartilage. The mechanism limits the movement of the joint to flexion and extension, all rotatory movement being prevented.

cases in which, notwithstanding the use of the above instrument, the cartilage is constantly being dislocated, the joint may be opened and the cartilage fixed by sutures or removed.

THE ANKLE.—The astragalus, together with the rest of the bones of the foot, may be dislocated from the socket formed for it by the tibia and fibula, in an outward, inward, backward, forward, or upward direction. All five varieties are generally complicated by fracture of the fibula, or of the internal malleolus. The *outward* and *inward* varieties will be described under the head of Fracture of the Fibula (see p. 462). The *backward* and *forward* varieties are rare; the latter especially so. In the former (Fig. 203), the astragalus is either partially or completely driven backwards from its socket, carrying with it, of course, the other bones of the foot; so that the foot appears shortened, the heel prominent, and the tendo Achillis tense. In the *forward* variety the astragalus is generally forced only partially from between the malleoli, and the foot appears lengthened, the heel less prominent than natural, and the tendo Achillis relaxed. In the *upward* variety the tibia and fibula are torn asunder, and the astragalus is forced upwards between them. The ankle appears widened, the malleoli are almost in contact with the ground, and all motion at the ankle-joint is lost. *Treatment.*—The leg having been flexed and the foot extended to relax the calf-muscles, make extension on the foot whilst an assistant holds the thigh, and then manipulate the bones into position. If necessary, give an anæsthetic, and cut the tendo Achillis. Place the foot and leg on a back-splint, or, if preferred, on a Cline's or Dupuytren's splint.

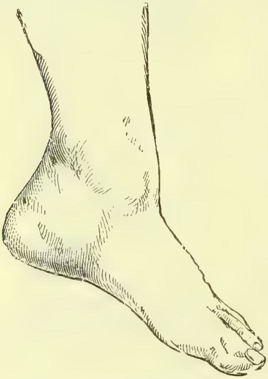


FIG. 203.—Dislocation of the foot backwards. (St. Bartholomew's Hospital Museum.)

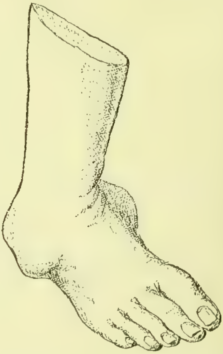


FIG. 204.—Subastragaloid dislocation. (St. Bartholomew's Hospital Museum.)

Compound dislocation of the ankle.—In young and healthy subjects an attempt should be made to save the foot, unless the main vessels are torn, or there is much comminution of the bones, or extensive laceration of the soft parts, when amputation is the safer course. Resection of the bones, however, may, in some instances, be undertaken with advantage, but each case must be judged on its merits, and the indications for resection cannot be discussed here.

THE ASTRAGALUS may be dislocated from the tibia and fibula above and from the os calcis and scaphoid below and in front, in a forward, backward, inward or outward direction; whilst very rarely it may be rotated on its own axis either vertically or horizontally. The forward dislocation, which is generally produced by a wrench of the extended foot, is the most common, the bone in this variety usually inclining either a little outwards, or a little inwards at the same time. The backward dislocation most often occurs from a wrench when the foot is flexed. The lateral dislocations when complete are always compound, and nearly always associated with fracture of the malleoli. *Signs.*—The astragalus in the *forward* variety can be felt projecting under, and often threatening to protrude through the skin of the instep; whilst in the *backward* form it gives rise to a prominence beneath the tendo Achillis which it causes to bulge backwards, to shortening of the foot, and to a projection of the tibia in front. The *lateral* varieties being compound, the nature of the injury is obvious. *Treatment.*—In the simple form attempts should always be made to push back the displaced bone into its socket by making pressure in the proper direction, the calf-muscles being relaxed by position, the foot extended, and the tendo Achillis, or any other tendon or ligament that is felt tense, divided if necessary. An anæsthetic is generally required. If reduction is then found impossible, the rule is to leave the displaced bone alone, and only to exercise it if sloughing threatens or has actually occurred. Seeing, however, how successful are the results of excision of the astragalus for intractable cases of club-foot, I should myself, if I failed to reduce the bone, remove it at once. In a compound dislocation the bone should, as a rule, be excised.

THE SUBASTRAGALOID DISLOCATION is one in which the bones of the foot are displaced from the astragalus, which itself retains its natural connections with the tibia and fibula. The foot is generally displaced either backwards and inwards, or backwards and outwards; more rarely in the opposite directions. In the backward and inward variety (Fig. 204) the foot is inverted, the sole looks inwards, the external malleolus is prominent, the internal malleolus is buried by the projection of the os calcis beyond it, and the head of the astragalus forms a distinct prominence on the outer side of the instep, over which prominence the skin is tightly stretched. In the backward and outward variety the foot is everted instead of inverted, the internal malleolus is prominent, the external buried, and the astragalus projects on the inner side of the instep. The forward varieties are too rare to require description. The normal relations of the head of the astragalus to the malleoli, together with the signs above given, will serve to distinguish it from dislocation of the astragalus alone, the injury with which it is most liable to be confounded. *Treatment.*—In the backward varieties the foot should be drawn forwards, whilst the leg is forced backwards, the tendo Achillis and the tibialis anticus and posticus being divided if necessary, and the patient put under an anæsthetic. Reduction is sometimes very difficult or even impossible in consequence of the tibial tendons hooking round the head of the astragalus, or of the mutual interlocking of the bones. After reduction the foot should be placed on a splint, and an ice-bag applied. If sloughing occurs, Pirogoff's or Syme's operation may have to be performed.

DISLOCATION OF THE SEPARATE BONES OF THE TARSUS, OF THE METATARSAL BONES, AND OF THE PHALANGES OF THE TOES are too rare to require special description.

Fractures of the Lower Extremity.

FRACTURES OF THE FEMUR may be divided into fractures of—I. *the upper end;* II. *the shaft;* and III. *the lower end.*

I. FRACTURES OF THE UPPER END OF THE FEMUR may be divided into—1, intracapsular fracture of the neck; 2, extracapsular fracture of the neck; 3, fracture of the great trochanter; and 4, separation of the epiphysis of the head.

1. INTRACAPSULAR FRACTURE occurs most frequently in the old, and more commonly in women than in men. *Cause.*—The atrophy and fatty degeneration of the bone and the diminished obliquity of the neck which is said frequently though not invariably to attend old age, are the chief predisposing causes. Professor Humphry maintained, however, that there is no diminution of obliquity as age advances. Slight indirect violence, such as slipping off the curbstone, catching the toes in the carpet, &c., is the common exciting cause.

State of the parts.—The line of fracture may be situated at any part of the neck within the capsule, and may be transverse or oblique; the usual situation, however, is just external to the head, and the direction transverse. The fragments may be impacted or non-impacted, but impaction is the exception. In the impacted form the lower fragment is nearly always driven into the upper;

when, however, the fragments are very jagged, mutual interlocking may occur. The periosteum covering the neck—the cervical reflection as it is sometimes called—may be partially or completely torn, so that all connection between the head and the rest of the bone is severed. Upon the extent of its rupture will in part depend the amount of displacement of the fragments, and the kind of union that will occur. In the non-impacted form the lower fragment with the rest of the femur is drawn slightly upwards by the muscles inserted into the trochanters, and at the same time generally rotated outwards. The outward rotation would appear to depend in part on the direction of the line of fracture, and in part on the weight of the limb, which has a natural tendency to roll outwards. *Method of union.*—In consequence partly of the feeble blood supply of the upper fragment, and partly of the fragments not being in apposition, bony union seldom occurs, the parts becoming bound together by fibrous tissue or remaining ununited. In the latter case the fragments become rounded off and polished, forming a false joint; whilst, owing to the absorption of the lower fragment, great shortening of the neck usually ensues.

Signs.—Slight shortening — about three-quarters of an inch, eversion, inability to raise the limb from the horizontal position, approximation of the great trochanter to the anterior superior spine of the ilium, rotation of the great trochanter through a smaller arc than on the opposite side, and crepitus, are the usual signs. Occasionally there may be no shortening at first, and patients have been known to walk after the injury. In rare instances there has been inversion instead of eversion, a fact not easy of explanation. In the *impacted form* there is no crepitus, the shortening is less, and does not disappear on extension, and the patient may be able to raise the limb from the horizontal position, and perhaps stand or walk on it. *Diagnosis.*—The age of the patient, the very slight shortening, the absence of bruising about the trochanter, the slightness of the violence occasioning it, and the eversion of the limb, are the chief signs which point to intracapsular fracture; but it may have to be diagnosed from the extracapsular form, from dislocation of the hip, from dislocation with fracture of the acetabulum, from chronic osteo-arthritis, and from mere contusion of the hip. In the *extracapsular* form the shortening is greater, the patient usually younger, the occasioning violence direct and more severe, and there is often bruising and ecchymosis of the skin and widening of the trochanter. In *dislocation* there is loss of mobility of the limb, and the head of the bone can be felt in the abnormal position. The only common dislocation with which the ordinary form of fracture could be confounded is the pubic, as in this alone is there any eversion; but here the distinct prominence formed by the head of the bone on the pubes at once serves to distinguish it. In *fracture of the acetabulum with dislocation* there is, in addition to crepitus, the presence of the head of the bone in an abnormal situation, whence it can be drawn on extension of the limb, but returns when the extension is relaxed, crepitus during these movements being felt. *Chronic osteo-arthritis*, in which in consequence of the absorption of the head of the bone there is often shortening and eversion, and in consequence of the movement of the osteophytes upon each other crepitus, may be distinguished from intracapsular fracture, which it may simulate should a patient suffering from it have a fall, by the history of pain, lameness, and stiffness before the injury. In *contusion* of the hip, though there may be eversion of the limb and loss of power, the trochanter retains its normal relations, and there is no shortening or crepitus. It should be remembered, however, that in old people absorption of the neck of the bone may slowly take place after a contusion, and of this the patient should be warned, as otherwise the surgeon may be accused of overlooking a fracture.

The treatment should vary according to the age and powers of the patient. Thus in the old and feeble in whom bony union can scarcely be expected, and in whom, moreover, long confinement on the back is liable to produce bed-sores and even fatal hypostatic congestion of the lungs, the limb should be merely placed at rest between sand-bags, and the patient only confined to bed for a few days. He should then be allowed to get about on crutches with the parts secured in some form of stiff bandage or moulded leather case, or on a Thomas's hip-joint splint. In younger and fairly vigorous patients an attempt may be made to obtain bony union either by means of extension with the weight and pulley or by the long splint. Confinement to bed for six or eight weeks is usually necessary, followed for another two or three months by the use of some form of stiff apparatus.

2. EXTRACAPSULAR FRACTURES, though more frequent in the old than in the young are not, like intracapsular fractures, so essentially an injury of old age. Thus, they are frequently met with between the ages of forty and fifty, whereas intracapsular fractures hardly ever occur in persons under fifty. *Cause.*—Usually direct violence, as a fall or a severe blow on the great trochanter. *State of the parts.*—The fracture commonly extends through the base of the neck just outside the capsule, and is nearly always associated with a fracture of the great trochanter. It may be impacted or non-impacted, the former condition, however, being by far the most common. Indeed, it is probable, that nearly all extracapsular fractures are in the first instance impacted and accompanied by fracture through the great trochanter, and that they only become non-impacted by the splitting asunder of the trochanters, in

consequence of the neck being driven in still further wedge-wise between them; and hence that non-impaction only occurs as a result of great violence. The line of fracture through the trochanter commonly extends obliquely downwards and backwards, and terminates by passing through the trochanter minor; but it may take various directions, sometimes splitting the trochanter into several pieces. The *method of union* is generally bony, and as the blood supply is very good, there is often an excessive formation of callus. In rare instances no union, or fibrous union occurs.

The *signs* are similar to those of the intracapsular variety. Thus, there is eversion and shortening of the limb, pain on movement, inability as a rule to raise the limb from the ground, and the top of the trochanter is found to be above Nélaton's line (Fig. 191), and the base of Bryant's triangle to be less than on the sound side. But the shortening is greater than in intracapsular fracture; the patient is commonly not so old; the fracture is probably produced by direct violence; the trochanter feels enlarged and thicker than that of the opposite side, from being split by the neck; there is swelling and bruising about the hip; and often much subsequent ecchymosis, since the blood being outside the capsule readily makes its way to the surface. In the *non-impacted* variety where there is much comminution of the trochanter, the shortening may be as much as two or three inches, and crepitus will be well marked. In the *impacted*, the shortening is much less, seldom exceeding an inch, and crepitus cannot be elicited, unless the fragments are loosely wedged. In firm impaction, indeed, the patient can often raise the leg, or even walk.

Treatment.—In the non-impacted variety, extension should be applied by means of some variety of Liston's long splint, a stirrup, weight and pulley being substituted, if preferred, for the perineal band. Firm osseous union will generally be obtained in a month to six weeks. In the impacted, extension had better not be made, but the limb merely kept at rest by the long splint till the swelling and pain have subsided, and the patient then allowed to get about on crutches. Firm union will occur, but there will be permanent shortening, and probably some eversion and stiffness of the joint.

3. FRACTURE OF THE GREAT TROCHANTER; and 4, SEPARATION OF THE EPIPHYSIS OF THE HEAD, are too rare to call for description here.

II. FRACTURES OF THE SHAFT OF THE FEMUR are very common in children, less common in adults, and rare in old people, in whom intra- and extracapsular fractures more readily occur. *Cause.*—Generally the result of indirect violence, occasionally of direct, and rarely of muscular action. *State of the parts.*—The line of fracture is usually transverse or oblique; but in rare instances, almost longitudinal or spiral. The oblique is more common in adults; the tranverse in children. The fragments for the most part considerably overlap, producing much shortening. The usual situation of the fracture is about the middle of the bone, though it may occur through the upper or middle or lower third. In the *upper third* (Fig. 205), the lower end of the upper fragment is drawn forwards by the psoas and iliacus, and at the same time, generally abducted and rotated outwards by the glutei and external rotator muscles. The upper end of the lower fragment is drawn inwards by the adductors, and upwards by the quadriceps and hamstrings, whilst it is also rotated outwards in part by the adductors, and in part by the weight of the limb. Occasionally, the upper fragment is drawn inwards instead of outwards. Union is apt to occur with some overlapping of the fragments and angular deformity. In the *middle third* the displacement is similar, the upper fragment usually projecting in front and to the outer side of the lower. In the *lower third* the upper fragment, in addition to being displaced forwards, is generally drawn towards the middle line by the adductors; whilst the lower fragment, especially when the fracture is just above the condyles, is tilted backwards into the popliteal space by the gastrocnemius, where it can be felt as a distinct prominence, and at the same time is drawn upwards with the rest of the limb by the ham-strings and quadriceps (Fig. 206).

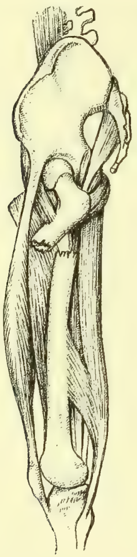


FIG. 205.—Fracture of upper third of femur. (After Gray.)

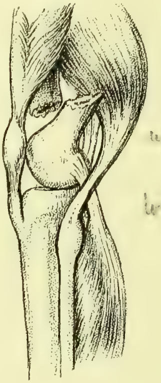


FIG. 206.—Fracture of lower third of femur. (After Gray.)

upper frag.
= forwards in
lower frag
- backwd
upward

Signs.—In the adult the signs are usually very obvious. They consist in shortening, crepitus, eversion of the foot, swelling from the approximation of the attachments of the muscles, and in preternatural mobility and loss of power in the limb. The ends of the fragments, moreover, can often be felt on manipulation. In young children the diagnosis is not always so easy, especially when the fracture is incomplete; the bowing of the limb, shortening, sensation of yielding or creaking, and the history of the accident, however, will usually prevent a mistake.

Treatment.—The methods of treating fractures of the shaft of the femur are very numerous; they have all for their object the extension of the limb. Extension overcomes the spasmodic contraction of the hamstrings and adductors, and through the insertion of the quadriceps into the anterior surface of the upper fragment draws the lower end of the latter backwards, thus counteracting the psoas and iliacus. The various methods may be briefly considered under the following heads:—1, the long splint; 2, the weight and pulley; 3, the double-inclined plane; 4, the plaster-of-Paris or starch bandage.

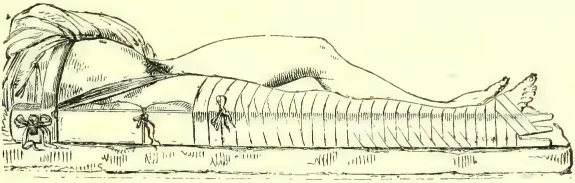


FIG. 207.—Liston's long splint. (Heath's Minor Surgery.)

1. *The long splint* (Fig. 207) in its simplest form consists of a straight lath with two notches at its lower, and two holes in its upper end, and is known as Liston's. It should reach from the axilla to six inches below the foot. The splint, well padded, is first bound to the foot and leg by a bandage carried through the notches in the splint, and over the ankle in the form of a figure of **8**, and then up the leg, and beyond the knee to prevent relaxation of the ligaments of the joint (Fig. 207). A perineal band having been previously adjusted, and its ends brought out through the holes in the top of the splint, is now tightened, whilst extension is made upon the foot. The ends of the perineal band, as soon as the fracture is reduced, are securely tied. The band thus acts as a counter-extending force, and the displacement is prevented from returning. A broad bandage is finally passed round the thorax to confine the splint to the side. The perineal band may consist of any soft material, as a folded silk handkerchief, or "piece of bandage

sewn in the form of a long bag and stuffed with cotton wool," with tapes attached at each end. It should take its bearings from the tuber ischii, and not rest between the tuber ischii and great trochanter, as here it would press on the great sciatic nerve. The splint is improved by a cross-bar at its lower end, to prevent the limb rolling outwards, and by an oval aperture opposite the external malleolus, to prevent pressure on that bone. As the perineal band is apt to chafe, some surgeons, in its place, employ, in combination with the long splint, the stirrup, weight and pulley for the purpose of extension, raising the bed at the foot so that the weight of the body may act as the counter-extending force. Many modifications of the long splint are in use; amongst these may be mentioned Boyer's, Desault's, Bryant's, and De Morgan's splints. Bryant's (Fig. 208) consists of two long splints united above and below by iron cross-bars in the way shown in the drawing, and interrupted opposite the trochanters to avoid pressure on these parts. By its use both limbs are kept parallel, and abduction or adduction of the fractured limb is prevented, whilst extension is kept up by means of the elastic apparatus attached to the side of the splint, and connected by cords and pulleys to the foot-piece, which moves up and down in a slot. If the foot of the bed is raised no perineal band is required.

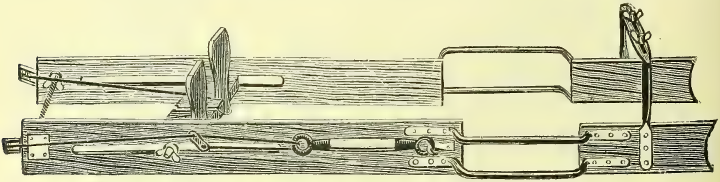


Fig. 208.—Bryant's splint.

2. *The weight and pulley* is frequently used, either alone, or as an addition to the long splint. A long piece of strapping is secured on each side of the leg and lower third of the thigh by strapping and a bandage, leaving a loop about eight inches long under the sole. In the loop thus left a flat piece of wood, about two inches square, is placed, and through a hole in the centre of this a cord is passed and secured by a knot at its end. The cord is then carried over a pulley at the foot of the bed, and a weight of several pounds suspended on it. The weight should be gradually increased till the fractured limb is found on measurement to be the same length as the sound limb. Ten to twenty pounds or even more may be required. Counter-extension is made by the weight of the body, the foot of the bed being raised six inches or so on blocks. But the many details involved in its application will be better learnt by

three months' dressing in the wards than by any verbal description. In children, the limb or better both limbs may be suspended by means of this stirrup in a vertical position to the ceiling (Fig. 209), the weight of the body being the counter-extending force.

3. *The double-inclined plane* is very useful in the treatment of fractures of the upper third of the femur, in which the upper fragment is tilted upwards by the psoas and iliacus, and cannot be kept in apposition with the lower. By means of the double-inclined plane the lower fragment is raised and brought into line with the upper, extension being secured by the leg and foot hanging unsupported down the further side of the plane, and counter-extension by the weight of the body. The plane may consist of an ordinary MacIntyre's splint bent to the proper angle, or of a wooden frame that can be adjusted to the proper height at the apex where the planes meet. Dr. Hodgen's and Dr. Nathan Smith's splints are double-inclined planes slung on pulleys, but space does not permit of them being described here.

4. *Plaster-of-Paris and starch bandages* are employed at some hospitals from the first, and the patient allowed to get about on crutches.

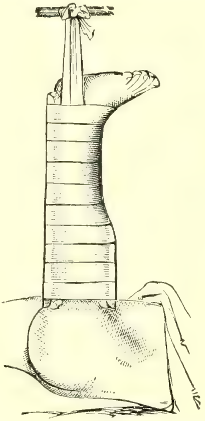


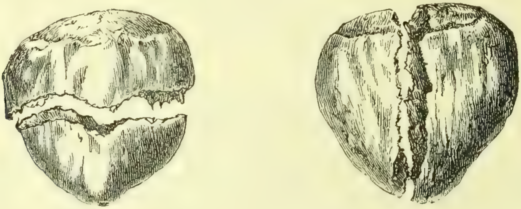
FIG. 209.—Fracture of the femur treated by vertical extension. (Bryant's Surgery.)

III. FRACTURES THROUGH THE LOWER END OF THE FEMUR very frequently extend either transversely or obliquely across the shaft, just above the articular surface, and vertically or obliquely between the condyles into the knee-joint, the broken end of the shaft being often impacted between the partially-separated condyles. Sometimes the line of fracture may be entirely supra-condyloid, the knee-joint then escaping. In young subjects the fracture may occur in the epiphysial line with or without splintering of the condyles. Destructive inflammation of the knee-joint is liable to follow fractures through the condyles, but is certainly far from common.

The *signs*, when the fracture is *supra-condyloid*, are similar to those of fracture of the lower third of the shaft. In the T-*shaped fracture* in which the knee is involved, there is usually great swelling of the joint from effusion of blood and serum; increased width of the femur if the condyles are separated from each other; shortening; nability to stand on or use the limb; and crepitus on manipulation, on grasping the condyles, and often on moving the patella laterally. In *fracture through the epiphysis*, the age of the patient, and the soft crepitus characteristic of epiphysial fractures, will point to the nature of the injury. The separation of the fragments, moreover, is usually less than in other fractures in this situation, as the two surfaces are broad. Union generally occurs by bone; hence epiphysial growth is arrested and shortening is common.

Treatment.—Some form of the long splint may be applied; or extension made by the stirrup, weight, and pulley; or the limb may be placed on an iron back-splint, with two side splints, and slung in the way to be described under fracture of the bones of the leg. In the supra-condyloid fracture, where the lower fragment is much tilted backwards by the gastrocnemius, the tendo Achillis may be divided, or the double-inclined plane used. In any case an ice-bag or lead lotion should be applied to the knee till the effusion is absorbed. Passive movements should be begun at the end of about four weeks.

THE PATELLA.—Fractures of the patella are most common in middle life, of more frequent occurrence in men than in women, and very rare in childhood. *Cause.*—They are generally due to a sudden and violent action of the quadriceps extensor muscle, such as is exerted by a person to regain the upright position when he feels himself slipping backwards, the knee being then semi-flexed, and the patella unsupported. They are sometimes caused by direct violence, as a blow or fall upon the knee. *State of the parts.*—When due to muscular action the line of the fracture is transverse (Fig. 210), the aponeurotic covering is usually torn, and the upper fragment generally drawn some distance from the lower by the action of the quadriceps extensor. When due to direct violence it is more often starred or vertical (Fig. 211), and the aponeurosis being intact, there is little or no separation. In any case the fracture, of course, extends into the joint. *Method of union.*—When the fracture is transverse, union is generally fibrous or membraneous, rarely osseous, in consequence of the fragments being separated, probably in part by muscular contraction, in part by the effusion of blood and later of serous fluid into the joint, but chiefly by flaps of the torn aponeurosis falling between the fragments. In the vertical and starred fractures, where the parts are held together by the



FIGS. 210 and 211.—Transverse and vertical fracture of the patella.

untorn aponeurosis, union is usually osseous. *Signs.*—At first a gap between the fragments can be seen and felt, but it is subsequently obscured by swelling of the joint. The patient cannot stand, or extend the knee. In a vertical fracture crepitus can usually be detected, and the fragments are not separated.

Treatment.—If seen before effusion has occurred, the whole limb from the ankle to the hip may be enclosed in a Bavarian plaster-of-Paris splint, and the patient confined to bed for a week, and then allowed to get about on crutches. Even when effusion has set in, this plan may be attended with good results. Usually, however, the limb is placed on a back-splint with the foot raised so as to relax the muscles in front of the thigh, ice or cold lotion applied till the swelling has subsided, and then an endeavour made to draw down the upper fragment as nearly as may be into contact with the lower. Various forms of apparatus are employed for this purpose, amongst which may be mentioned Manning's, Hamilton's and Steavenson's splints, Malgaigne's hooks (Fig. 212), and Mayo Robson's pins (Fig. 214). But plaster of Paris applied in the way above described, after the fragments have been as much as possible approximated by strips of strapping, is one of the best methods short of wiring that can be adopted. On the removal of whatever apparatus is used, at the end of six weeks or two months a leathern knee-cap, to prevent flexion, must be worn from three to six months, and subsequently an apparatus to partially limit flexion for two or three years, as otherwise there is a great tendency for the fibrous material uniting the fragments to become stretched, and the fragments to become widely separated.

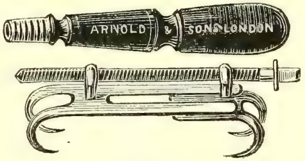


FIG. 212.—Malgaigne's hooks, with key.

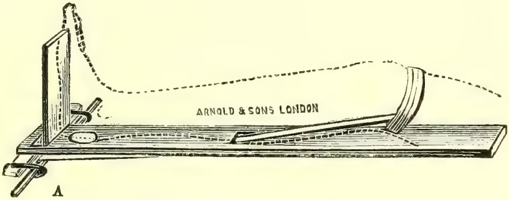


FIG. 213.—Manning's patella splint. The leg is drawn in outline, so as to show beneath it the webbing band passing through the slit in the splint. The strips of strapping should reach up the thigh to the gluteal fold.

Manning's splint.—A piece of webbing is taken the length of the leg, and is first secured to the back of the thigh by a dozen or so strips of strapping, which have been previously sewn to the webbing, the lowest strip being an inch or two from the patella. The whole limb is then placed on a back-splint with a foot-piece, the leg and foot being firmly bandaged to it below, and the thigh lightly to it above. The free end of the webbing band, having first been brought out through the slit in the splint midway between the knee and the ankle (see Fig. 213), is now drawn down towards the foot-piece outside the splint, and sewn over a piece of stick, which is secured to the foot-piece by an india-rubber ring (A) on each side. Thus elastic tension is continually exerted upon the upper fragment, and so draws it down towards the lower.

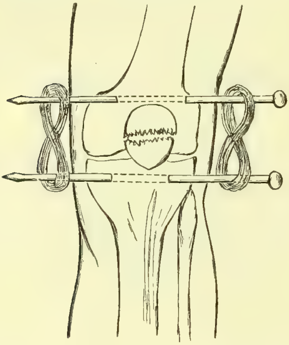


FIG. 214.—Mayo Robson's method of holding fragments of patella in contact.

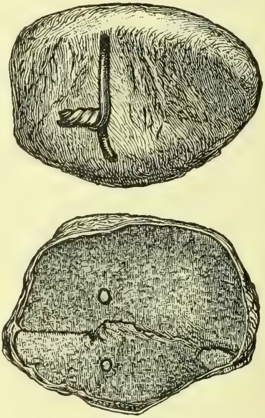


FIG. 215.—A patella divided vertically to show the method of wiring. (St. Bartholomew's Hospital Museum, No. 988 *b*.)

Mayo Robson's method.—A strong steel pin is passed through the ligamentum patellæ outside the knee joint; the skin is then drawn down over the patella, and another pin passed through the tendon of the quadriceps also outside the joint. The two pins and with them the fragments of the patella are then drawn together by a figure-of-eight suture on each side, so as to bring the fractured surfaces into apposition. An antiseptic dressing is applied, and the pins allowed to remain *in situ* for a month (see Fig. 214).

Aspiration of the joint. Wiring of the fragments.—With the object of obtaining firm fibrous union, some surgeons, where there is much distension of the joint, draw off the blood or serum with the aspirator. Others lay the joint freely open and wire the fragments of the patella together, a proceeding which, when successful, ensures firm bony union, though on the other hand it has been followed by suppuration, stiff-joint, amputation and even loss of life. In the face of these facts, therefore, and considering that no such dangers attend the ordinary methods, and that by these methods a fairly useful joint can be obtained even though the union is only fibrous, no surgeon should attempt wiring unless he is thoroughly familiar with the antiseptic treatment of wounds, and is sure that this treatment can rigorously be carried out. The fracture having been exposed by a vertical incision, each fragment is drilled obliquely from the anterior surface to the lower part of the fractured surface, so that the wire when tied is not in the interior of the joint. The flaps of aponeurosis between the fragments should be held aside so that the bony surfaces are brought into contact. Mr. Barker ties the fragments together subcutaneously by passing a suture of thick soft wire by the aid of a nævus needle first behind the patella, and then in front of it between the patella and the skin. The blood is squeezed out of the joint, the fragments pressed together, and the sutures tied tightly, thus keeping the fragments in apposition. The flaw in this procedure, as in the other methods in which the joint is not opened, is that the flaps of aponeurosis remain between the fragments and prevent the bony surface from being brought into contact.

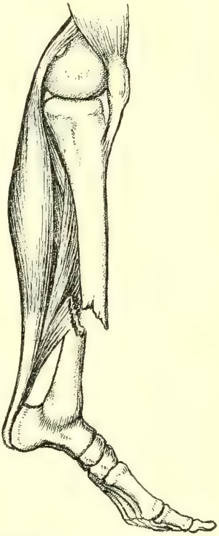


FIG. 216.—Fracture of the lower third of the tibia. (After Gray.)

THE TIBIA AND FIBULA.—Both bones, or the tibia or fibula alone, may be fractured.

Fracture of both bones, which is by far the most common variety, may be due to either direct or indirect violence. When the result of direct violence, the fracture occurs at the spot where the force is applied, and both bones are usually fractured more or less transversely, and in the same line; but when the result of indirect violence, the tibia generally first gives way at its weakest spot, *i.e.*, about the junction of the middle with the lower third, and then the fibula also at its weakest spot, *i.e.*, in its upper third, and the fractures are usually oblique. In the transverse fracture but little displacement occurs; in the oblique, in which the line of fracture usually runs downwards, forwards, and a little inwards, the lower fragments are drawn upwards, backwards and outwards, behind the upper, by the muscles of the calf, while the sharp end of the upper fragment of the tibia projects forward threatening, and indeed often causing, perforation of the skin (Fig. 216).

Fracture of the tibia alone is generally *caused* by direct violence, as a kick or a blow on the shin, occasionally by indirect violence, as a fall on the foot. *Nature of the displacement.*—The fracture is usually situated in the lower third of the bone, and is generally transverse, and attended by little displacement, the fragments being held in position by the fibula, which plays the part of a splint. Fractures of the upper and lower ends, involving the knee- and ankle-joints respectively, and separation of the upper and lower epiphysis, may also occur, but are rare.

Fracture of the fibula alone is more common than fracture of the tibia alone. *Cause.*—Though sometimes produced by direct it is more often the result of indirect violence, such as a severe wrench or twist of the foot. The fracture is then generally situated from two to three inches from the external malleolus, and the foot is at the same time very commonly dislocated either outwards or inwards, according to the direction of the force. *Nature of the displacement.*—In the fracture with outward dislocation of the foot (*Pott's fracture*, as it is generally called), the upper end of the lower fragment is driven inwards towards the tibia, the external lateral ligament remains intact, but the internal lateral ligament is ruptured, or the end of the internal malleolus is torn off. The foot, at the same time that it is displaced outwards, is also drawn *backwards* by the tendo Achillis. In the fracture with inward dislocation (which is rare), the articular surface of the external malleolus usually follows the astragalus, and the upper end of the lower fragment of the fibula in consequence projects outwards.

Signs.—In fracture of both bones the signs are usually unmistakable, especially when the fracture is oblique and in the lower third of the leg. When the tibia or fibula alone is fractured the diagnosis is often very difficult. In the tibia some irregularity may be felt on running the finger along the shin, and crepitus may perhaps be elicited. In the fibula, fracture of the lower third may be detected by running the finger along the subcutaneous surface of the bone just above the external malleolus; but if the case is not seen till swelling from effusion has set in, it may be quite impossible to say whether we are dealing with a fracture or a sprain. If in doubt the case should be treated as a fracture. In the upper two-thirds, where the bone is covered with muscles, and cannot be felt, the following tests for fracture may be applied. 1. Move the foot laterally, and crepitus will probably be elicited if there is a fracture. 2. Press the tibia and fibula together just above the ankle by grasping them with the hand. In fracture, pain will be felt at the fractured spot, not at the situation where grasped. 3. Grasp the tibia and fibula with the hands just below the knee and above the ankle. If there is a fracture the natural springiness of the fibula will be lost, and crepitus may perhaps be detected. In *Pott's fracture* (Fig. 217), the foot is twisted outwards, so that whilst the inner edge is towards the ground the sole is directed outwards. There is a well-marked depression over the seat of fracture, the internal malleolus projects prominently under the skin, and crepitus can be easily obtained. There is also marked *backward* displacement of the foot.

Treatment.—In uncomplicated fractures of the tibia or fibula alone, the leg may be placed at once in plaster-of-Paris splints, and the patient, after a few days' rest in bed, allowed to get about on crutches. Where there is much swelling, the leg had better be placed for a few days on a back-splint to allow the swelling to subside before the plaster of Paris is applied. In simple fracture of both bones, where the line of fracture is transverse and there is but little swelling or displacement, the same treatment may often be adopted with advantage. But greater care and watchfulness will be necessary to prevent any untoward accident. Indeed, whenever this method of treating fractures is used, the precautions mentioned at page 164 *et seq.* should be taken. When there is any displacement, however, the fracture must be reduced by making traction upon the foot whilst the thigh is steadied by an assistant, special care being taken to correct the eversion, so frequently present, of the lower fragment. The surgeon will know when this has been done by the inner side of the patella, the internal malleolus, and the inner side of the great toe being in the same line. Further, he should not, as a rule, rest satisfied as long as any irregularity can be felt on drawing the finger down the crest of the tibia, or as long as any marked difference is apparent on comparing the fractured with the sound leg. If any difficulty is experienced, give an anæsthetic and if necessary, cut the tendo Achillis. Having reduced the fracture, secure the foot and leg on a splint. Whatever form of the various splints for the purpose is adopted, take care:—1, that the foot is at right angles to the leg; 2, that the ball of the toes and the heel touch the foot-piece of the splint; 3, that the foot is square with the foot-piece; and 4, that the back of the heel is kept from contact with the splint by a small pad placed under the tendo Achillis just above the heel. The iron splint and cradle, shown in Fig. 218, is

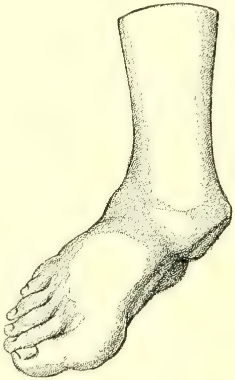


FIG. 217.—Pott's fracture. (St. Bartholomew's Hospital Museum.)

almost invariably employed by the whole of the surgical staff at St. Bartholomew's Hospital for ordinary fractures of the tibia and fibula and with the most satisfactory results. In applying the splint, which should reach as high as the junction of the middle with the lower third of the thigh and should be well padded and shaped to the limb, the foot is first secured to the foot-piece by strapping and a bandage. The surgeon having then assured himself that the fracture is in good position, secures the splint by a broad strip of strapping, and a figure-of-eight bandage over the knee. The splint is next swung in the cradle, as shown in the figure, and side splints are then applied and fixed by webbing straps. In the case of fracture of both bones, the apparatus is generally kept on for a month; in the case of the fibula or tibia alone, for two or three weeks. The leg is then placed in a plaster-of-Paris, a gum and chalk, or a silicate of soda bandage. In *Pott's fracture*, the above apparatus is also generally used, and here again I speak of it

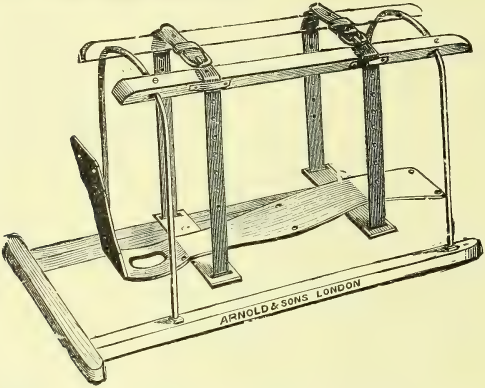


Fig. 218.—Fracture apparatus for the bones of leg.

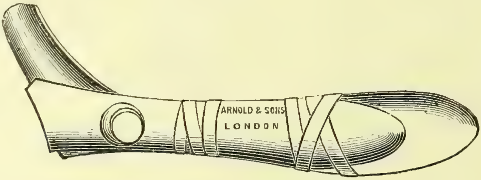


Fig. 219.—Cline's splints for Pott's fracture. The outside splint is known by the foot-piece.

in the highest praise. Where, however, there is much difficulty in keeping the bones in good position, the leg is sometimes laid on its outer side, with the knee semi-flexed to relax the gastrocnemius, and secured in Cline's splints (Fig. 219), the tendo Achillis being divided, if found necessary. The backward displacement of the heel, however, is best corrected by using Roughton's modification of this splint (Fig. 220). It consists of an outside splint with a foot-piece. The heel is drawn forward and secured in position

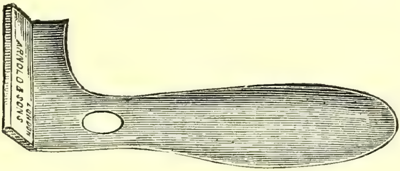


Fig. 220.—Modified Cline's splint for Pott's fracture.

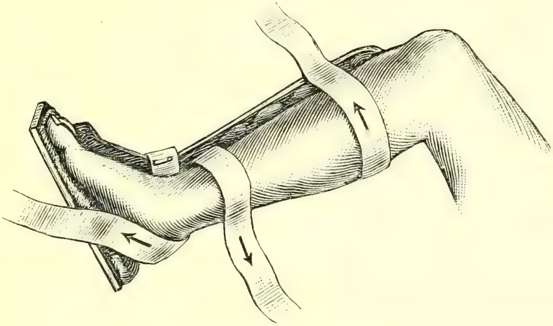
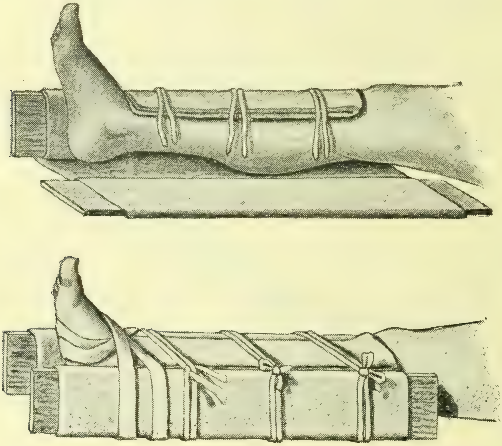


Fig. 221.—Roughton's method of applying the modified Cline's splint in Pott's fracture. The arrows show the direction in which the bandages pull.

Fig. 222.—Dupuytren's splint for Pott's fracture.

y a "heel bandage," the limb being fixed to the splint by two ther bandages, one placed just above the ankle and the other just elow the knee (Fig. 221). At times Dupuytren's splint (Fig. 222) ay be better adapted to a particular case. The splint consists of straight lath notched at its lower end. It is placed on the inner ide of the limb, and should reach from the tuberosity of the tibia to three or four inches below the foot. A wedge-shaped pad, with its base below, and not extending beyond the internal malleolus, should line the splint. The splint is bandaged on from above downwards, and the leg having been thus secured, the foot is brought over to the splint by making figure-of-eight turns over the ankle and foot and through the notches at the lower end of the splint. The bandage should not pass over the external malleolus or the seat of fracture. The great objection to the use of this splint is, that having no foot-piece, the foot is not kept at a right angle to the leg. When no special apparatus is at hand the fracture, whether of both bones of the leg or of one bone only, may be put up in what is known in Edinburgh as the box-splint (Figs. 223, 224). All that is required is two ordinary side splints and some towels, cotton wool, and a few bandages. The splints should be rolled in the two ends of a long towel (Fig. 223) so as to form a trough for the fracture, the width of the trough being determined by first placing the sound leg in it. The fracture having been set the leg is placed on the towel and the splints forming the sides of the trough or box are raised and secured in position by slip-knot bandages (Fig. 224). Pads formed of folded towels should be placed over the tibia or where required, and the foot fixed at a right angle to the leg by a figure-of-eight bandage (Fig. 224). Backward displacement of the heel may be controlled by a ring pad.



Figs. 223, 224.—The box-splint for fracture of the bones of the leg. In the upper figure the position of a towel used as a pad is shown. In the lower figure the apparatus is shown completed. (After Caud and Cathcart.)

Cases of *badly-set Pott's fractures* frequently come under notice. In such the foot which has been allowed to remain everted becomes flat, and there is usually much thickening about the internal malleolus, limitation of movement at the ankle, and pain on attempting to walk. In several of these cases I have succeeded in replacing the foot after osteotomy of the fibula and excision of a wedge of bone from the internal malleolus. The results obtained were excellent; the deformity was overcome and the patient enabled to walk without pain or discomfort.

THE TARSUS.—Fractures of the bones of the tarsus are for the most part the result of great violence, and are rare. The only one calling for passing notice is *fracture of the os calcis*, which may occur from a fall on the heel, passage of a wheel over the foot, or violent contraction of the calf-muscles. Crepitus, and when the line of fracture is behind the interosseous ligament, some drawing up of the posterior fragment by the tendo Achillis, are the chief signs. But where there is much swelling and bruising of the soft parts, the fracture, as is the case in fractures of the astragalus and of the other tarsal bones, may be very difficult to diagnose. Rest, with the foot and leg on a splint, in such a position as to relax the calf muscles where there is much displacement, and an ice-bag to subdue inflammation, are the points to be attended to with regard to treatment. When the case is seen early, and there is but little swelling, a plaster-of-Paris splint or bandage may be advantageously used.

THE METATARSAL BONES AND PHALANGES of the toes may be fractured by direct violence. No special description, however, of these fractures is necessary.

SECTION VI.

Diseases of Regions.

DISEASES OF THE SCALP AND SKULL.

Erysipelas of the scalp is common, and may occur idiopathically, or as the result of a wound. In the so-called idiopathic cases, however, it is probable that there is generally some scratch or abrasion through which the specific micrococcus gains admission. The inflammation spreads with great rapidity, but is accompanied by very little redness and swelling, on account of the tenseness of the parts. It is apt to be attended with headache, drowsiness, or delirium, consequent upon the hyperæmia extending to the pia mater. *See* Erysipelas, p. 131.

Cellulitis of the scalp is usually due to a wound, and is described under Injuries of the Scalp. (*See also* Cellulitis.)

Abscess may occur above the aponeurosis, between the aponeurosis and the pericranium, or beneath the pericranium. It is generally the result of an injury, but may be due to the breaking down of a gumma, disease of the bones, &c. It is further referred to under Injuries of the Head (p. 325).

Rodent ulcer, and epithelioma of the scalp, require no special mention here.

Sebaceous cysts are very common on the scalp, where they are at times hereditary. They are frequently multiple, and as they increase in size, the hair covering them falls off, and they appear as bare, rounded tumours, dotted over the surface with the enlarged hair follicles. The signs, secondary changes, diagnosis, and treatment of these cysts have been given at p. 85. All that need here be repeated is that the mass of granulations which sometimes protrudes from the walls of these cysts (*fungating ulcer of the scalp*) closely resembles epithelioma, from which, however, it may generally be distinguished by the absence of induration and glandular enlargement, and by the history of a sebaceous cyst having been previously present. At times a chronically ulcerated sebaceous cyst may actually become epitheliomatous; the margins of the ulcer then become indurated, sinuous and everted. Congenital and dermoid cysts are described at p. 89.

Nævi are also common on the scalp. When large and situated over the anterior fontanelle they should be dealt with cautiously lest the membranes of the brain be injured and meningitis result.

Secondary changes in sebaceous cyst see p 85

CARIES AND NECROSIS of the bones of the cranium are not uncommon. They are generally the result of syphilitic periostitis or injury, or very rarely of tubercle or fevers. The external table is the most often affected, but whether the external or the internal table is involved, the disease seldom extends beyond the diploë, as the two tables have a distinct blood supply. At times, however, complete perforation of the skull occurs. Caries and necrosis in this situation are apt to be followed by septic or infective inflammation of the diploë and its consequences; by suppuration between the bone and dura mater; by meningitis and abscess of the brain; or by thickening of the dura mater, resulting in persistent headache or even epilepsy. When the skull is completely perforated, the hole is not filled up by bone; and when necrosis occurs the sequestrum is not invaginated. *Treatment.*—Beyond keeping the parts aseptic, providing free exit for the discharges, and removing loose sequestra, little, as a rule, is required. Should pus collect between the bone and dura mater, it must be let out by the trephine; and a portion of necrosed inner table may also require the trephine for its removal. Appropriate constitutional remedies for syphilis or tubercle will of course also be necessary.

EXOSTOSES of the skull are described under Diseases of Bone, p. 223.

MENINGOCELE AND ENCEPHALOCELE are rare congenital tumours, formed by a protrusion of the membranes of the brain through an unossified part of the skull. They are believed to be dependent upon hydrocephalus, the excess of fluid in the sub-arachnoid space or in the ventricles of the brain leading respectively to a protrusion of the membranes alone (*meningocele*), or of the brain also (*encephalocele*). In the latter instance, the dilated ventricle may extend into the protruding portion of brain, a condition further distinguished as *hydrencephalocele*. The protrusion is most common in the occipital region (Fig. 225), just behind the foramen magnum, between the four centres from which this part of the occipital bone is ossified, or the supra-occipital may be absent, so that the sac protrudes through what is apparently a greatly dilated foramen magnum (Fig. 225). It is next most common at the root of the nose, between the frontal and nasal bones; but it may occur in any situation in the course of the sutures, and even project into the nasal fossæ or pharynx. *Symptoms.*—In the occipital region these tumours are generally pedunculated and of large size—sometimes nearly as large as the child's head; at the root of the nose they are usually small and sessile. The skin covering them is generally normal. They swell up when the child cries, and can be completely or partially reduced on pressure, the reduction sometimes producing convulsions or other brain symptoms. When they contain fluid only (*meningocele*) they are soft, fluctuating, translucent, and completely reducible on pressure; they rarely pulsate, and are generally pedunculated. When they contain brain-matter (*encephalocele*) they are doughy, non-fluctuating, opaque, and only partially reducible; they pulsate, and are usually sessile. They may be mistaken for other tumours of the scalp, but especially for congenital dermoid cysts and

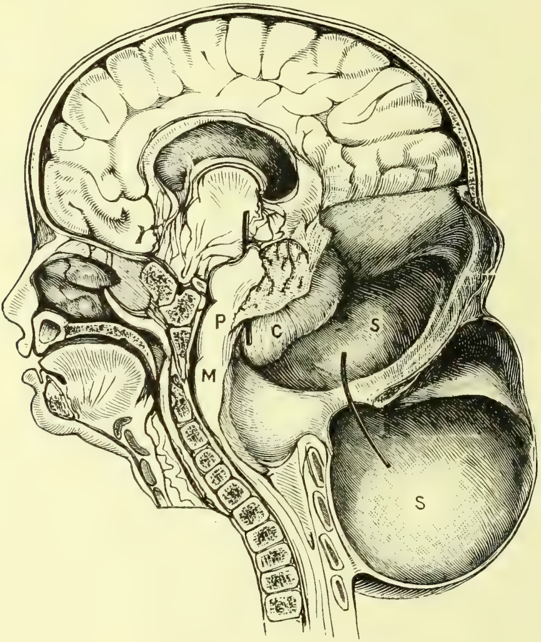


FIG. 225.—Section through head and neck of a child showing the relations of an occipital meningocele. The supra-occipital is absent so that the foramen magnum is enormously enlarged, and through this aperture, in which a glass rod is placed, the intra- and extra-cranial portions (S S) of the sac communicate. The pia mater covering of the meningocele is well seen both in the intra- and extra-cranial parts. The cerebellum (C), pons (P), and medulla (M) are displaced by the pressure of the fluid. The meningocele is in direct communication with the ventricles through the foramen of Majendie and the iter of Sylvius. A second glass rod indicates this communication.

degenerate nævi. However, their intimate connection with the bone, their situation in the course of the sutures, and their partial or complete reducibility, together with the facts that they swell up on expiratory efforts, and occasionally pulsate synchronously with the brain, will usually serve for their diagnosis. Further, the hole in the skull may at times be detected and brain symptoms be produced by pressure. *Treatment.*—As a rule they should be left alone, or merely supported by a pad and bandage. A meningocele, when pedunculated, and apparently communicating with the interior of the cranium by a small aperture only, may be injected with Morton's fluid, or under exceptional circumstances excised.

FUNGOUS TUMOURS, generally of a sarcomatous nature, and springing either from the tissues of the scalp or pericranium, or from the diploë or dura mater and then penetrating the bone, are occasionally met with, and may be mistaken for inflammatory affections of the pericranium or bone, or for syphilitic gummata. Their rapid growth, resistance to syphilitic remedies, the escape of blood only on puncture, and the concomitant loss of weight and strength of the patient, will usually serve to distinguish them; but an exploratory incision may in some cases be necessary to clear up the diagnosis. Secondary tumours which pulsate and have the structure of thyroid-gland tissue, are also very occasionally met with in cases of malignant goitre. *Treatment.*—Where there is no evidence of dissemination, and the tumour is small and fairly circumscribed, it may be removed. When growing from the scalp this can usually be done without much difficulty; but when the growth arises from the bone or dura mater a much more serious operation will of course be required, since a considerable portion of the skull will have to be cut away and the dura mater probably opened. It need hardly be said that the strictest antiseptic precautions must be observed.

DISEASES OF THE BRAIN THAT MAY CALL FOR SURGICAL INTERFERENCE.

ABSCESS in the brain is generally the result of middle-ear disease or of a head injury, and, when its situation can be localized with a fair amount of probability, imperatively calls for surgical interference. When the result of middle-ear disease the abscess is generally situated in the temporo-sphenoidal lobe (Fig. 226) or in the cerebellum. *See* Intracranial Suppuration (p. 343) and Complications of Middle-Ear Disease (p. 486).

THE TUMOURS and new growths in the brain suitable for operation are gliomata and psammomata, localized tuberculous lesions, syphilitic scars which drugs cannot absorb, scar-tissue and cystic formations following injury, and parasitic cysts. Sarcomatous and carcinomatous growths are usually too extensive for removal, or are multiple from the first. Moreover, since they have no capsule they are not sufficiently distinguishable from the surrounding brain substance to ensure their complete excision and their non-return in the scar. The *chief signs* of a cerebral tumour are vomiting, persistent headache, optic neuritis, localized spasms or paralyses, and epileptiform convulsions, the convulsive seizures usually starting in the part connected with the cortical area involved in the growth (*Jacksonian Epilepsy*). Among the symptoms that may enable the surgeon to *localize* the growth are the following (Figs. 227 and 228):—1. If at the beginning of the epileptiform fit there is—(*a*) pain, peculiar sensation, flexion, or hyper-extension of the great toe, a lesion of the leg-area on the opposite side of the cortex at the upper end of the fissure of Rolando close to the middle line is indicated; (*b*) movement of the shoulder, a lesion near the upper part and rather in front of the fissure; (*c*) flexion of the thumb, a lesion about the genu of the fissure; (*d*) turning of the head and eyes to the opposite side, a lesion in the hinder portion of the superior and middle frontal convolutions; (*e*) movements of the mouth and tongue, a lesion located at the lower end of the fissure of Rolando. An epileptiform movement starting in one of these parts may be followed by loss of power in the part for some time after the fit. 2. Aphasia indicates a lesion of Broca's convolution. 3. Loss of half the fields of vision in both eyes points to a lesion of the angular gyrus of the side opposite to the lost fields of vision. 4. Loss of hearing suggests a lesion of the two upper temporo-sphenoidal lobes. 5. The aid to localization that may be derived from the involvement of the cranial nerves has already been mentioned under Injuries of the Head (p. 340).

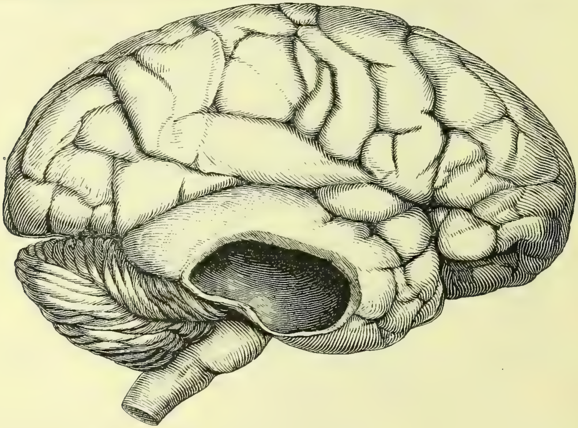


FIG 226.—Large abscess in the temporo-sphenoidal lobe of the brain, the result of otitis media. (St. Bartholomew's Hospital Museum.)

Where, from a consideration of the above symptoms, a tumour or new growth is believed to be fairly circumscribed and in an

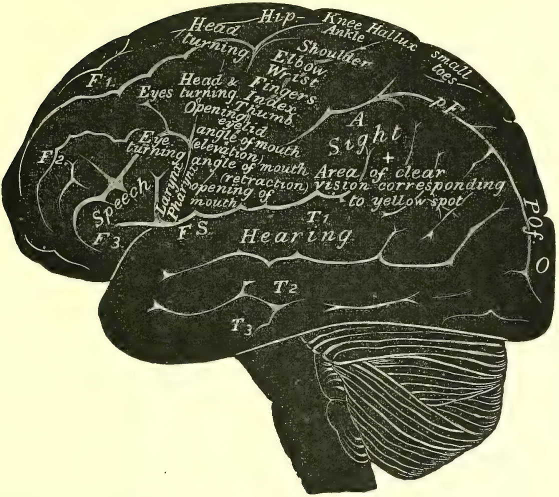
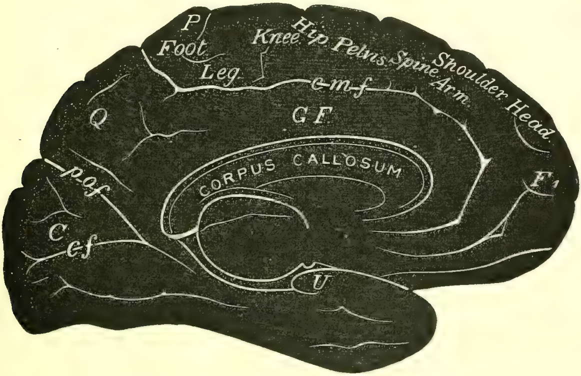


Fig. 227.—The convolutions of the outer surface of the left cerebral hemisphere with the cortical centres marked. F^1, F^2, F^3, First, second, and third frontal convolutions ; T^1, T^2, T^3, First, second, and third temporo-sphenoidal convolutions ; A. Angular convolution ; O. Occipital lobe ; F S. Sylvian fissure ; P O F. Parieto-occipital fissure ; P F. Intra-parietal fissure.



ig. 228.—The convolutions of the median surface of the left cerebral hemisphere with the cortical centres marked. F^1, First frontal convolution ; C M F. Calloso-marginal fissure ; G F. Gyrus fornicatus ; Q. Quadrate lobule ; C. Cuneate lobule ; P O F. Parieto-occipital fissure ; C. F. Calcarine fissure ; U. Uncinate lobule ; P. Paracentral lobule.

accessible situation, the skull should be trephined, a sufficient portion of the bone removed, to fully expose the growth, by a Hey's saw, Hoffmann's or Keen's forceps, or the surgical engine, and the growth cut away by making perpendicular incisions into the brain around it and raising it by means of a sharp spoon. The removal of a portion of the cortex will be followed by loss of function of the area removed, but this to a great extent will be regained by the aid of the surrounding areas, especially as regards the coarser movements. The finer movements of the fingers and thumb will not be completely regained; hence in this region the removal of cortex should be as limited as is consistent with success. Parasitic cysts should be drained. *See* Trephining, p. 346.

FOCAL EPILEPSY, GENERAL PARALYSIS, CEPHALALGIA.—In *focal epilepsy*, that is epilepsy without obvious gross lesion, when the fits become very frequent, for example more than one an hour, and the mental processes are becoming further impaired, the focus in the cortex representing the initial movements may be exposed, the exact spot for the initial movements found by exciting the brain with the Faradic current, and this area of the cortex excised. After such an operation a diminution in the number of fits as well as an improvement in the health of the patient may be expected. In *general paralysis* trephining in a few cases has been of some benefit in the early stages of the disease. Thus the hallucinations have disappeared and the patient has so far improved as to be fit to be at liberty. In *severe cephalalgia* incapacitating the patient for work or preventing sleep, trephining may give relief. In such cases an exostosis, a spiculum of bone, an enlarged Pacchionian body, or a fibrous tumour or cyst of the dura mater has been found, and its removal has been followed by complete recovery. In other cases where a tumour, &c., of the brain which did not permit of removal has been discovered, the relief of pressure has freed the patient from the excessive pain or threatened blindness.

HYDROCEPHALUS, especially (*a*) when accompanied by fits, (*b*) when progressive atrophy of the optic nerve threatens, or (*c*) when dementia or coma supervenes, may be treated by tapping the ventricles at intervals and applying slight pressure to the skull, or if this fails, by continuous drainage of the ventricles.

MICROCEPHALY COMBINED WITH IDIOCY, due it is thought to too early synostosis of the cranial sutures, especially the sagittal and coronal, may be benefited by craniectomy, *i.e.*, the removal of a strip of bone on either side of the middle line of the skull. The aim of the operation is to allow the brain, the development of which has been prevented by the early synostosis, to expand. In some of the cases reported, the mind of the child had continued to develop since the operation.

CRANIECTOMY.—Having prepared the scalp as described under trephining (p. 346), make a semicircular incision over the side of the head, extending from a little behind the external angular process of the frontal bone to a little in front of the middle of the lambdoid suture; turn down the large semicircular flap thus marked out, and apply a half-inch trephine over the parietal bone two inches or so external to the sagittal suture. Gently separate the dura mater and cut away with Hoffmann's or Keen's forceps a narrow strip of bone some five or six inches long from the parietal and frontal bones, parallel to the sagittal and interfrontal sutures. Care should be taken during the operation to make as little pressure as possible on the brain. At the end of the operation the flap should be replaced and accurately secured by sutures. The operation should be repeated on the opposite side of the head when the first wound has healed. I have performed this operation on four patients, but sufficient time has not elapsed to say what improvement in their mental condition, if any, will result.

The strictest antiseptic precautions in this as in all operations on the skull and brain should of course be taken. *See* Trephining, p. 346.

DISEASES OF THE EAR.

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St. Bartholomew's Hospital.

Physical examination of the ear.—In making an examination of a patient, let him be seated between the surgeon and the source of light, with the affected ear towards the examiner. Throw the light on the ear with the mirror and notice any abnormal condition of the auricle or the external meatus. Next grasp the auricle between the middle and index fingers, the speculum (Fig. 229) between the index finger and thumb, and pulling the auricle upwards and backwards, insert the speculum with a gentle rotatory movement. Any epithelium or wax that may obstruct the view should be removed by means of forceps (Fig. 230), or the syringe. If the canal be unobstructed, the membrana tympani can be seen stretching across its deeper part as a delicate bluish-grey or yellowish-grey semi-transparent and highly polished film. Near the upper and anterior margin is a whitish prominence—the *processus brevis*, and running downwards and backwards from this, to a point just below the centre of the membrane, is the *handle of the malleus*. From the tip of the handle a cone of light extends downwards and forwards, with its base to the periphery. From the processus brevis

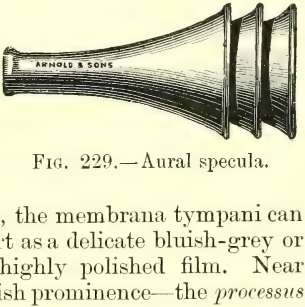


Fig. 229.—Aural specula.

two indistinct lines extend backwards and forwards—the *anterior and posterior folds*. If the membrane be very thin or its posterior segment much retracted, the *long process of the incus* can be seen, posterior to and parallel with, the handle of the malleus. The portion of membrane above the anterior and posterior folds is called *Schrapnell's membrane*, and consists only of the dermoid and mucous layers. Whilst noting these points, carefully search the membrane for perforations, opacities, or small polypi. After thus inspecting the membrane, its mobility should be ascertained by means of 1, the pneumatic speculum, or 2, by forcing air into the tympanum through the Eustachian tube, either by (*a*) Valsalva's method, (*b*) by Politzer's method, or (*c*) by the catheter.

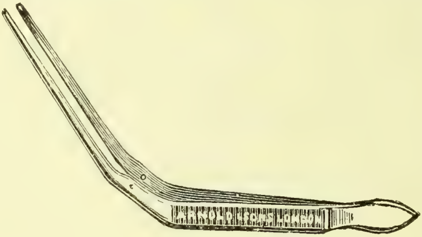


FIG. 230.—Aural toothed forceps.

(*a*) *Valsalva's method* consists in making forcible expiration with the nose and mouth closed.

(*b*) *Politzer's method.*—Direct the patient to take a mouthful of water; insert the end of the india-rubber tube into one nostril, carefully close the unoccupied portions of this and the other nostril with the index finger and thumb; tell the patient to swallow, and sharply compress the bag (Fig. 231). In small children the tympanum can be inflated without their drinking water. Some patients find a difficulty in swallowing easily when told to do so; such persons should be made to say some guttural word such as "Huck."

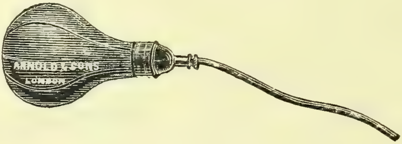


FIG. 231.—Politzer's bag.

(*c*) *To pass the Eustachian catheter* (Fig. 232), hold the instrument lightly between the forefinger and thumb and pass it quickly along the floor of the nose, keeping the point of the instrument downwards till it reaches the back of the pharynx; next draw it forward about three-quarters of an inch, gently rotating outwards at the same time, till the point is felt to ride over the posterior lip of the Eustachian orifice, and further rotating it till the ring of the catheter is in a line with the outer canthus of the eye, push the instrument slowly onwards, when the point will be in the Eustachian orifice. Another method for reaching the orifice of the tube is to draw the instrument forward over the back of the soft palate till the point begins to ride over the posterior border of the hard palate, then turn it upwards and outwards as before. These are the two best methods. If the mucous membrane of the nose be very irritable, first paint the inferior meatus with a 10% solution of cocaine or eucaine. Occasionally owing to post-nasal thickening, deformity of the septum or enlargement of the inferior turbinal, the catheter either cannot be passed, or else when passed cannot be turned. In such cases give the catheter a greater curve, and attempt to reach the tube through the other nostril. When air enters the tympanum *freely*, it is heard distinctly to impinge on the tympanic membrane. If the Eustachian tube be *narrowed*, the air is heard but feebly, or not at all, to impinge on the membrane. If *fluid* be present, either in the tube or in the tympanum, a bubbling or gurgling sound is heard. If the tympanic membrane be *perforated*, the air is heard to whistle through the perforation. To hear these sounds in the tympanum it is necessary while inflating to use the *diagnostic tube*, which is nothing more than a piece of india-rubber tubing 18 inches long, one end of which is inserted into the patient's, and the other into the surgeon's, ear.

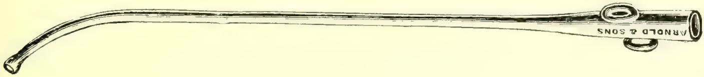


FIG. 232.—Eustachian catheter.

Having thus examined the condition of the external and middle ear, the next step is to ascertain if possible the condition of the auditory nerve. If a vibrating tuning-fork be applied to the vertex of the head in the middle line the sound is heard equally in both ears. In this case the sound is conducted directly to the labyrinth by the cranial bones. If now one meatus be closed by the finger, the sound is heard with greater intensity in that ear. The explanation offered of this phenomenon is that many of the waves of sound prevented from escaping through the tympanum and meatus, are thrown back and intensified. If, then, a patient who is deaf on one side, hears the tuning-fork better with the *ffected* ear, it may be assumed that the lesion is in the sound-onducting apparatus; while if he hears better with the *sound* ear, some affection of the labyrinth or auditory nerve may be suspected. Another way of testing the condition of the labyrinth is to place the vibrating fork on the mastoid process of the affected ear, and when the patient can hear it no longer, for the surgeon to transfer it to his own mastoid, and note if he can still hear it himself. If so, the length of time it can be heard by him after the patient has ceased to hear it, is an indication of the extent of the affection of the nerve-conducting apparatus. There are certain rare exceptions to the truth of what is here stated, but it is impossible to discuss the subject further in so limited a space. To complete the examination of a patient, test his hearing by means of the watch and voice, and finally examine the nares and pharynx in cases where there is reason for suspecting that an unhealthy condition of these parts may be the exciting cause of the ear-mischief.

I. Diseases of the external ear.—The auricle is liable to attack from various diseases, but it will only be necessary here to notice two: Eczema and Hæmatoma.

Eczema may be acute or chronic; primary, or secondary to eczema of the head. In the *acute form* there is great redness and swelling of the auricle; it is hot, tense, and tender, and later a crop of vesicles appear which exude a serous fluid soon drying into crusts; these, when they fall off, leave a raw surface. Acute eczema rarely invades the meatus. The *chronic variety* may attack the whole auricle; more frequently it is limited to some part of it. There is little or no redness, the surface is dry and scurfy, and fissured in places, and the disease generally spreads into the meatus, and sometimes even to the drum-membrane. In such cases there is more or less deafness, accompanied, it may be, by tinnitus, and a stuffy feeling in the ear. *Treatment.*—In the acute stage apply lead and opium lotion, or powdered zinc and starch in equal parts; later, useful applications are linimentum calcis, or ung. hydrarg. subchlor. (ʒj. ad ℥j.). If the parts continue red and swollen, paint them with argenti nitratis (ʒss. ad aq. f℥j.), and then apply powdered boracic acid, or ung. hydrarg. oxidi. rub. (gr. ij. ad ℥j.). Applications to the meatus must be applied with a small brush; the parts should be washed with oatmeal instead of soap. *Constitutional treatment* must not be neglected.

Hæmatoma auris may occur spontaneously or as the result of an injury, and is not uncommon among the insane. It consists of an effusion of blood between the cartilage and perichondrium on the anterior surface of the auricle. It occurs as a hard and rarely fluctuating swelling, varying greatly in size. The skin over it is of a more or less livid hue, but occasionally is hardly discoloured. There is a feeling of warmth or tingling, but rarely of pain. After a time it gradually becomes smaller and may entirely disappear. Sometimes it suppurates. In the end the auricle is left more or less deformed. *Treatment.*—At first the application of ice or cooling lotions; some recommend tapping it and injecting iodine; others laying it open and dressing it with a weak solution of carbolic or boracic acid. Of course, if it suppurates, it must be opened freely.

II. DISEASES OF THE MEATUS:—DIFFUSE INFLAMMATION is caused by injury, irritants (such as scratching the meatus with a pin), or sea-bathing. There is redness and swelling of the skin lining the meatus, a sense of fulness, and throbbing and occasional tinnitus, followed by serous or semipurulent secretion. After a time the epithelial lining becomes whitish and sodden, and, on syringing, comes away in flakes, or even as a cast of the meatus, leaving the surface beneath red, and frequently obliterating the demarcation between the meatus and tympanic membrane. Rarely the tympanic membrane may be perforated. There is pain, increased by movements of the jaw or pressure on the auricle, and sometimes fever. *Treatment.*—In the early stages cold compresses, and a leech or two to the tragus; and antiphlogistics. As soon as secretion is established, instil a warm solution of boracic acid, and later equal parts of alcohol and water, or blow in powdered boracic acid. If the discharge prove obstinate, the surface may be painted with a solution of nitrate of silver (ʒss. ad f℥j.), or liquor plumbi subacetatis.

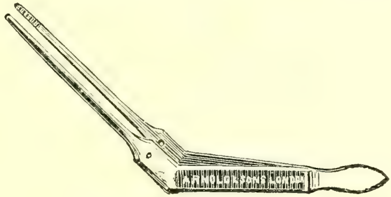


FIG. 233.—Aural forceps.

FURUNCLES.—Small boils frequently occur in the meatus in gouty, anæmic, and diabetic patients; also in those whose nervous system has been greatly taxed. The attack begins with pain, often of the greatest intensity, radiating over the side of the head and ncreased by movements of the jaw, or the slightest pressure on the auricle. There may be deafness as the result of closure of the meatus, not otherwise. Examination shows little or no redness, but one or more swellings, often closing the meatus. These are exquisitely tender when touched. As soon as the abscess bursts he pain subsides, but very often one abscess after another forms, ill the patient's life becomes a burden to him through pain and leeplessness. *Treatment.*—Apply hot fomentations, a leech or two o the tragus, and instil a concentrated solution of boracic acid in alcohol. Often a plug of cotton-wool soaked in glycerine and laudanum, and gently inserted into the meatus by the aural forceps shown at Fig. 233, or Gruber's medicated gelatine bougies, give relief. When the abscess is fully formed incise it, but not before, as early incision is excessively painful and gives but temporary relief. The general health should be attended to, and full doses of opium given to procure sleep. Von Tröltsch recommends arsenic to prevent the recurrence of furuncles.

IMPACTION OF CERUMEN may be caused by changes in the configuration of the meatus, cleaning the ears with the end of a towel or ear-pick, the presence of a foreign body (such as a piece of cotton-wool inserted into the meatus and forgotten), and by alteration in the character of the secretion so that it is not easily removed by movement of the jaw, &c. The chief *symptom* is partial or complete deafness, generally coming on suddenly. There may be tinnitus or even giddiness, often persistent cough, rarely pain. Sometimes the impaction of cerumen is really due to a peculiar laminated desquamation of the skin of the meatus, which becomes mixed with wax, and thus forms a plug. *Treatment.*—If the wax be not very hard it can be at once removed by syringing with warm water, the auricle being pulled backwards and upwards, and the nozzle of the syringe directed along the upper and posterior wall. If any difficulty be experienced in removing the wax owing to its hardness, soften it first by dropping into the ear for a few nights a warm solution of bicarbonate of soda (gr. x. ad f℥j.). After removal gently dry the meatus with a cone of absorbent wool, and let the patient keep a piece in the meatus for a few hours.

OTOMYCOSIS is a chronic inflammation of the external auditory meatus due to the presence of a vegetable fungus. The chief varieties are *Aspergillus niger*, *flavescens* and *fumigatus*. The *symptoms* are a sense of fulness, tinnitus and occasional vertigo, more or less itching, and occasionally pain. On examination there is seen a slight serous discharge, and the meatus is more or less filled with masses of desquamating epithelium, which on removal resemble pieces of damp blotting-paper covered with black or dark yellow spots, while the dermis beneath is seen to be reddened and occasionally bleeding. Microscopical examination of the flakes at once reveals the parasitic nature of the disease.

The *Treatment* consists in frequently syringing with a warm solution of perchloride of mercury (1 in 1,000), or chlorinated lime (gr. ij. ad f℥j.), or hyposulphite of soda (gr. iv. ad f℥j.), and, when the meatus is thoroughly freed from the flakes, instilling alcohol.

AURAL EXOSTOSES may roughly be divided into the spongy and the ivory.

(*a*) The *Spongy* are single and generally pedunculated, are most commonly found at the junction of the cartilaginous and bony meatus, are rapid in growth, follow suppuration of the middle ear, and are frequently the result of ossification of granulations. *Treatment.*—They can generally be removed by seizing them with a pair of forceps and breaking them off.

(*b*) *The Ivory exostoses* or rather *hyperostoses* may be single, but are more often multiple. They vary from ridge-like elevations to rounded tumours with broad bases ; they are found near the orifice of the meatus, more or less blocking up the canal, and grow slowly. Syphilis, gout, irritation of the meatus, and sea-bathing are said to be the *exciting causes. Diagnosis.*—At first sight an exostosis may be mistaken for a polypus, but it can easily be distinguished by its hardness, its rounded and polished surface, and, in the case of an ivory one, by its extreme sensitiveness to touch. In addition it is not moist, while a polypus is. *Treatment.*—They should not be interfered with unless they cause deafness by completely closing the meatus, except in those rare cases where they are associated with discharge. In such cases, as they greatly lessen the lumen of the canal they should be removed to avoid the risk of pent-up matter. When their removal is necessary, this should be done through the meatus by means of a chisel and hammer, or the dental drill. Sometimes their removal is facilitated by turning the auricle forwards by an incision between it and the scalp, so as to fully expose the exostosis to view.

III. DISEASES OF THE MIDDLE EAR :—ACUTE CATARRH may be started by any condition which produces acute naso-pharyngeal catarrh, such as a severe cold, the exanthemata, &c. It may also be caused by sea-bathing, or by the use of the nasal douche. *Symptoms.*—The attack begins by a feeling of fulness in the head, followed by pain, which varies in character from a dull aching to a severe throbbing or stabbing ; there is more or less deafness and sometimes tinnitus, and even giddiness, and in severe cases febrile disturbance. On examination, the membrane shows at first but little change beyond a slight loss of lustre, and the presence of a fine streak of red along the posterior edge of the malleus-handle. In severe cases, the posterior segment of the membrane and the adjacent meatus are red, and this redness may spread over the entire membrane till the outline of the malleus-handle is lost. Vesicles and even small abscesses may form on its surface. Later the epidermis is loosened in white flakes, and finally the membrane distinctly bulges, when the effusion of fluid is great. The Eustachian tube is closed by swelling of its lining membrane. After some days, varying with the severity of the inflammation, resolution begins, or the fluid (mucus or pus) bursts through the membrane, and is discharged into the meatus. *Treatment.*—The patient should be confined to the house, or even to his bed, according to the severity of the attack. An aperient should at once be given, and an astringent gargle. If the pain is severe, a leech or two should be applied to the tragus. Cold compresses should as a rule be avoided, but hot fomentations are grateful to the patient and generally useful. The ear may also be gently syringed with warm water. If there be distinct bulging the membrane should be incised, especially if the pain persists. If there be any tenderness over the mastoid, this should also be leeched. After the severity of the symptoms has subsided, the tympanum should be inflated daily by means of the air-douche, and if the discharge continues, the ear syringed with a warm solution of boracic acid (1—40), night and morning, and a lotion of sulphate of zinc (gr. v. ad f℥j.), or equal parts of rectified spirit and water instilled; or after syringing with warm water and drying the meatus with absorbent wool, powdered boracic acid may be blown in. If the catarrh is non-purulent the membrane is rarely perforated; and even if perforation occurs, the aperture speedily heals after the escape of the fluid. Inflation by means of Politzer's bag should be continued with decreasing frequency till the hearing is restored.

Chronic purulent catarrh (popularly called *Otorrhœa*) follows the acute form of disease. After freeing the ear from discharge, the membrane appears thickened, yellowish from the presence of sodden epithelium, or if this has been removed, reddish in hue. In some part of it a perforation can usually be detected varying in size, the margins granular or clean cut. If large, the lining membrane of the tympanum can also be seen, varying in colour from pale pink to dark red, according to the degree of inflammation present. When very small and situated anteriorly the perforation sometimes cannot be seen, but its existence can be proved by inflating the tympanum and listening with the diagnostic tube. The amount of deafness present in chronic purulent catarrh varies greatly. There is rarely tinnitus, but giddiness is far from uncommon. It is in this form of disease that patients are specially liable to the complications which will be considered later. *Treatment.*—After attention to the general health, the most important part of the treatment is great cleanliness. If a quantity of half-dried secretion mixed with epithelial *débris* be found in the meatus, this should first be removed by the instillation of warm bicarbonate of soda (gr. x. ad f℥j.) for several nights, and then thoroughly syringing the ear. Next let the ear be syringed with warm boracic acid night and morning, and after drying the meatus blow in powdered boracic acid. If this treatment be unsuccessful, then try an alcoholic solution of boracic acid; or if this causes pain, the solution may at first be diluted with an equal quantity of water. Or sulphate of zinc (gr. x. ad f℥j.), or acetate of lead (gr. iij. ad f℥j.) may be tried.

If the perforation be large and the mucous membrane of the tympanum much swollen it should be touched with solid nitrate of silver, or a saturated solution of chromic acid. Often when the discharge has ceased, the membrane remains perforated, and there is considerable deafness. In such cases the hearing may be greatly improved by means of an *artificial membrane.*

Without here discussing how the artificial membrane acts, it is sufficient to say there are two kinds, known as Yearsley's and Toynbee's. 1. *Yearsley's* consists of a piece of moistened cotton-wool, rolled into an elongated plug, and applied with a pair of forceps specially designed for the purpose (Fig. 234). 2. *Toynbee's* consists (Fig. 235) of a disk of soft india-rubber with a piece of silver wire attached to the centre. The former has the advantage of being less irritating to the ear, and can be moistened with medicated fluids, should any discharge still persist, but it has the disadvantage of being more difficult to apply. Toynbee's is easily applied, but it is more irritating to the ear. There are various modifications of Toynbee's, the best being *Gruber's*. It is impossible to tell in any given case whether the artificial drum will succeed; this can only be ascertained by trial. When successful the artificial drum should only be worn at first for a few hours. The length of time should gradually be increased as the ear becomes accustomed to its presence. It should always be removed at night.

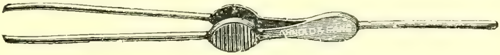


FIG. 234.—Forceps for inserting artificial drum.

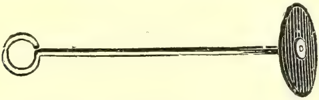


FIG. 235.—Toynbee's artificial drum.

ATTIC DISEASE is the name given to purulent catarrh of the upper and posterior part of the tympanic cavity which is practically cut off from the rest of the cavity by the projecting ridge of the aqueductus Fallopii, the upper part of the malleus and incus, and a fold of mucous membrane (Fig. 237, A and A¹). Posteriorly the attic communicates freely with the mastoid antrum. Although purulent catarrh of this cavity is usually part of a general catarrh of the tympanum, a very slight inflammatory swelling of its mucous lining may shut it off completely from the rest of the tympanum, and the retained matter escapes through Schrapnell's membrane. The discharge often persists after it has ceased in the general tympanic cavity, and, if long continued, as it frequently is, a small polypus appears through the perforation in Schrapnell's membrane. Continued discharge often leads also to caries of the head of the malleus or incus, and to the formation of caseous masses (*cholesteatoma*). The *Treatment* is the same as for purulent catarrh of the general tympanic cavity. If the discharge is obstinate, the cavity may be thoroughly cleansed by means of the intratympanic syringe, or it may be advisable to remove the malleus and incus, especially if either of these bones be carious. By so doing plenty of room is afforded for thorough irrigation of the cavity. If the inflammation extends to the mastoid cells the mastoid antrum must be opened and the attic carefully scraped.

Various *complications* may arise in the course of chronic purulent catarrh. These are 1, polypi; 2, mastoid disease; 3, caries and necrosis; 4, meningitis and intracranial suppuration; and 5, phlebitis and septicæmia.

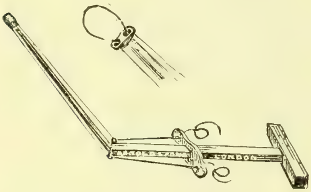


FIG. 236.—Polypus snare.

(1.) POLYPI may grow from the tympanic membrane, the meatus, or the tympanic cavity. Those growing from the meatus are not true polypi; but for brevity they will be all classed under the name of polypi. They vary much in size, being sometimes not larger than a mustard seed, at other times large enough to project beyond the external orifice of the meatus. They are usually bright red in colour, but may be pale pink, and when very large greyish yellow. They bleed more or less readily when touched. The diagnosis is easily made, but care must be taken not to mistake a swollen and vascular membrane for a polypus. In case of doubt the mobility of the latter, when touched with a probe, will settle the point. *Treatment.*—Polypi growing from the tympanic membrane should be destroyed with a saturated solution of chromic acid or perchloride of iron applied by means of a piece of cotton-wool twisted round a fine pair of forceps (Fig. 233). When the growth springs from the meatus, and is not too far in, it can easily be pinched off with a pair of aural forceps; when deeper in, it can be scraped off with a small sharp spoon. Those of larger size, especially when arising in the tympanic cavity, should be removed by the snare (Fig. 236). If the growth be of a large size, or long duration, and firm in structure, it is most easily removed by seizing it with a pair of dressing-forceps, and slowly twisting it round on its own axis. Care must be taken to fix the patient's head in order to avoid sudden movement on his part. However removed, the root of the polypus must be touched with a saturated solution of chromic acid or perchloride of iron till it is quite destroyed. It can also be more speedily destroyed by means of the galvanic cautery, but this necessitates the use of an anæsthetic. During the time occupied in destroying the root, the ear must be syringed twice a day with warm water, and alcohol dropped into the meatus and retained there some minutes.

(2.) Mastoid disease.—Not unfrequently inflammation of the tympanum spreads to the mastoid cells, especially to the large irregular cells (*mastoid antrum*) situated just behind and slightly above the external auditory meatus. Its *course* varies considerably. In mild cases the inflammation is superficial, and resolution soon takes place, or if more chronic there may be gradual ossification of the inflammatory products, and conversion of the mastoid cells into solid bone. More often there is suppuration with more or less softening and breaking down of the bony trabeculæ of the cells, and the formation of granulation tissue. As the disease progresses perforation of the bony walls occurs, most frequently on the surface of the mastoid process. The matter, however, may travel backwards, and may burst into the middle or posterior fossa of the cranial cavity. If the matter escapes on the inner side of the apex of the mastoid process, it burrows down beneath the deep cervical fascia into the neck. When the abscess makes its way into the cranial cavity there is considerable danger of thrombosis of the lateral sinus with pyæmia or encephalic abscess. The *Symptoms* are deep-seated tenderness on pressure, and when the periosteum is involved, redness and swelling; the ear also projects more or less unduly from the side of the head. If the abscess is making its way to the surface, there is after a time fluctuation. The febrile disturbance is generally more marked when the inflammation is deep-seated than when it is superficial. Sometimes, especially in more chronic cases, the symptoms are very obscure, there being little indication of the mischief beyond deep-seated pain, tenderness on firm pressure, and some fever. It is in such cases that the inflammation is apt to spread to the cranial cavity. *Treatment.*—In the early stages apply hot fomentations and leeches, and as soon as fluctuation can be detected, a free incision should be made into the swelling, and boracic poultices applied afterwards. In obscure cases, if the pain persists and the temperature remains above the normal, the cells should be opened by means of the chisel or gouge, so as to establish a free communication with the antrum.

(3.) Caries and necrosis.—The parts of the temporal bone most frequently attacked are, the mastoid process, the posterior wall of the meatus, and the roof of the tympanic cavity. It is generally easy to make a diagnosis, but when the deeper parts are affected it may not be possible to do so with certainty. The points that will help the surgeon are, facial palsy, the persistence of offensive discharge in spite of cleanliness, and granulations resisting all attempts at destruction. Even then it may be necessary to put the patient under an anæsthetic, and carefully examine with a probe. *Treatment.*—If the diseased bone can be reached without further injuring the hearing, it should be freely scraped or removed.

(4.) MENINGITIS AND INTRACRANIAL SUPPURATION.—Although meningitis may supervene in the course of acute purulent catarrh of the middle ear, it is generally in the course of the chronic disease that it arises. Intracranial suppuration may occur between the dura mater and the bone—*subcranial abscess*—or in the cerebrum or cerebellum. Subcranial abscess is generally found on the roof of the tympanum or on the posterior surface of the petrous bone; cerebral abscess in the hinder part of the middle temporo-sphenoidal lobe; cerebellar abscess in the anterior part of the lateral lobe. If in the course of chronic suppuration, headache, rigors, and a rise of temperature supervene, we may strongly suspect intracranial mischief, and if in addition there is photophobia, sluggish pupils, and optic neuritis, the diagnosis is all but certain. *Treatment.*—If the symptoms point to the probability of intracranial abscess the skull should be trephined, and an attempt made to reach the pus.

The position of the trephine openings to reach matter are the following:—(*a*) to reach the mastoid antrum the centre of the trephine opening should be $\frac{1}{2}$ inch behind, and $\frac{1}{4}$ inch above the centre of the external auditory meatus; (*b*) to expose the anterior surface of the petrous bone, and roof of the tympanum, the centre of the opening should be $\frac{7}{8}$ inch above the middle of the meatus; (*c*) to expose the lateral sinus, the opening should be $1\frac{1}{8}$ inch behind, and $\frac{1}{4}$ inch above the middle of the meatus; (*d*) to reach a temporo-sphenoidal abscess, trephine $\frac{3}{4}$ to 1 inch directly above the posterior margin of the meatus; (*e*) to reach a cerebellar abscess, trephine $1\frac{1}{4}$ inch behind, and $\frac{1}{4}$ to $\frac{1}{2}$ inch below the middle of the meatus. Use a half-inch trephine, and afterwards enlarge the opening when necessary with chisel, gouge, forceps, &c.

(5.) PHLEBITIS AND SEPTICÆMIA.—Phlebitis of the lateral sinus may supervene in the course of suppuration of the middle ear, especially when there is caries of some part of the tympanic walls. When followed by septic poisoning, the symptoms are headache, vomiting, rigor, followed by great rise of temperature, and sweating, tenderness over the mastoid, and in the course of the internal jugular vein; sometimes the glands between the pinna and the angle of the jaw are enlarged and painful to the touch. There is also frequently pain on making firm pressure at the posterior border of the mastoid process. There may be optic neuritis. *Treatment.*—Expose the lateral sinus by means of the trephine, or chisel, and if it be found plugged, or contains purulent matter, ligature the internal jugular vein in the neck, in two places, and divide it between the ligatures. Next lay open the lateral sinus, and, removing the clot, thoroughly wash out the sinus with solution of iodide or perchloride of mercury. If in doubt whether the lateral sinus be plugged, it may first be explored by means of a grooved needle. Even though the lateral sinus be free from clot or purulent matter, if there are distinct indications of septic infection due to the ear mischief, the jugular should still be tied, and the lateral sinus laid open and plugged.

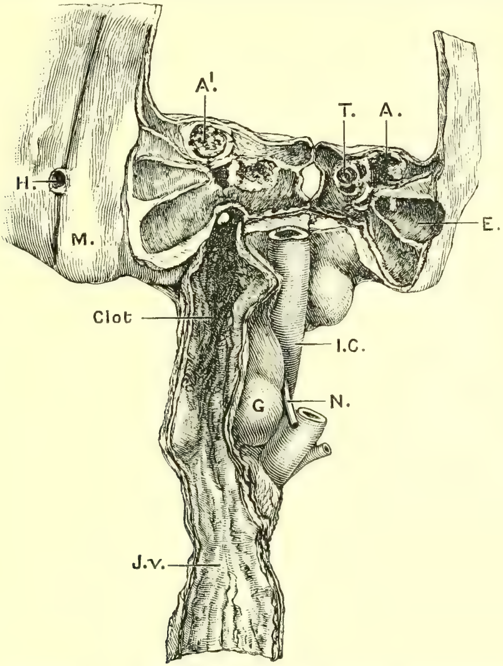


FIG. 237.—Section of the right temporal bone to show the effects of suppurative otitis media. The membrana tympani and some of the ossicles have disappeared ; the attic is enormously enlarged and still contains some pus as seen on the left side ; the internal jugular vein is filled and blocked by a dark breaking down clot. A and A¹. Attic. E. Section of external auditory meatus. G. Enlarged gland. I C. Internal carotid. J V. Internal jugular vein. H. Trephine hole to mastoid cells. M. Mastoid process. T. Tympanum. (St. Bartholomew's Hospital Museum, No. 2676*e*.)

CHRONIC NON-PURULENT CATARRH.—By far the largest proportion of cases of deafness met with are due to chronic catarrh. So many pathological conditions are included under this heading, that it is impossible to do more than to give a very general outline of the symptoms. The affection may result from an acute attack, but more generally is a chronic affection from the very first. Heredity, syphilis, gout, rheumatism, and gestation, are predisposing, and perhaps in some cases, exciting causes. Large doses of quinine, long continued, may also be an exciting cause. The disease at first progresses so insidiously, as often to remain unsuspected for some time. In many cases, tinnitus is the first and perhaps for a time the only symptom. More often, however, the earliest symptom is slight difficulty of hearing general conversation; later there is tinnitus, at first intermittent, afterwards persistent. Gradually the deafness increases till it becomes marked. This deafness varies greatly with the state of the weather and the patient's general health. There is rarely pain, and when present, it is transient, and never severe. There is often a sense of tightness in the head, and a feeling as if the ears were stopped with cotton-wool. Sometimes there is giddiness, and some patients hear perfectly in a *vibrating* noise, as for instance in a railway carriage. On inspection, the meatus is dry and shining; and occasionally it contains impacted cerumen, the removal of which, however, causes no improvement in hearing. The membrane varies greatly in appearance. At times it is normal, oftener more or less opaque; rarely is there any sign of congestion. The anterior segment may be retracted, the handle of the malleus being sharply defined, or the entire membrane may be cupped, and the handle drawn inwards and backwards. Opacities, calcareous deposits, and thinned spots are often seen. The cone of light may be altered in direction, may be broken into points, or may disappear. Rhinoscopic examination may show the naso-pharyngeal mucous membrane swollen, congested, and granular, or pale and dry. Adenoid vegetations may be present. The Eustachian orifice may be obliterated by cicatricial bands, or variously distorted. Inflation may prove the canal patent, or more or less obstructed. If the labyrinth be not seriously involved, the tuning-fork is heard louder in the affected ear. *Treatment.*—The nasal cavity and pharynx should be examined and as far as possible restored to a healthy condition (see Diseases of Nose and Pharynx). The patency of the Eustachian tube must be restored, if possible, by means of the air-douche, catheter, or electric bougie. The nostrils should be syringed through with warm saline solutions, and astringent gargles when necessary should be given, or the throat painted with nitrate of silver, chloride of zinc or glycerine of tannin. If these means fail, the chloride of ammonium inhaler may be tried or medicated fluids may be injected into the tympanum, such as bicarbonate of potash, iodide of potassium, vapour of iodine, or pilocarpine, although I cannot say I have observed much benefit from their use. Some surgeons recommend, in obstinate cases, perforating the membrane, and dividing the tensor tympani, the posterior fold, or the anterior ligament of the malleus.

IV. DISEASES OF THE INTERNAL EAR.—Our knowledge of diseases of the internal ear is still so imperfect, and our means of treatment so inadequate, that this part of the subject need not be discussed at any great length. Diseases of the internal ear, although often primary, are more frequently secondary to diseases of the middle ear. *The causes are:*—1. General diseases of the system, especially the zymotic diseases, such as scarlet-fever, measles, mumps, typhus, diphtheria, &c.; also anæmia, lactation, and especially syphilis. 2. Extension from the middle ear, either directly or indirectly by causing reflex vaso-motor changes in the labyrinth. 3. Intracranial mischief, such as aneurysm of the basilar artery, meningitis, abscess or tumours. 4. Sudden loud noises, such as heavy artillery firing. 5. Great emotion; and 6. Continued use of large doses of quinine. The *chief points of diagnostic value* are:—1. The vibrating tuning-fork placed on the middle line of the head is heard *less distinctly* with the deaf ear, or if both ears be affected, it is not heard at all or very indistinctly. 2. The tuning-fork when it has ceased to be heard through the cranial bones, can still be heard when placed opposite the meatus. 3. The tuning-fork when it has ceased to be heard by the patient, can still be heard by the surgeon. 4. The patient hears the tick of the watch proportionately better than speech. 5. There is generally nausea or vomiting, giddiness, and always tinnitus. None of these signs and symptoms when taken separately are of much value, but when taken together, they are strong presumptive evidence of mischief in the internal ear.

MENIÈRE'S DISEASE is a sudden hæmorrhagic effusion into the labyrinth. The *symptoms* are very marked. The patient, whose hearing was more or less perfect before the attack, is suddenly seized with intense tinnitus and giddiness, often so great as to cause him to fall. The giddiness is followed by nausea or actual vomiting, faintness, and cold sweats. On recovering somewhat, he finds he is deaf with one ear. The giddiness sooner or later passes off, but the tinnitus and deafness persist. If the deafness is absolute, the tinnitus may eventually disappear. *Treatment.*—Quinine, bromide of potassium, subcutaneous injections of pilocarpine, and electricity are recommended; but all treatment directed towards restoring the hearing is generally useless.

AUDITORY VERTIGO is characterized "by a sensation of motion referred by the patient either to himself, or to surrounding objects, which seem to revolve in certain defined planes" (McBride). The attacks are generally paroxysmal, but often there is more or less constant giddiness, with occasional exacerbations. As may be seen above, auditory vertigo is a prominent symptom in Menière's disease, but many causes may give rise to the symptom, such as (*a*) increased pressure on the secondary membranes of the tympanum induced by accumulations of wax in the meatus, forcible syringing, or retraction of the membrana tympani due to obstruction of the Eustachian tube; (*b*) fluid accumulations in the tympanic cavity; (*c*) vascular and nervous changes, or effusion and secondary formations in the labyrinth itself; (*d*) intracranial lesions; (*e*) dyspepsia, and (*f*) such drugs as quinine and salicin. *Treatment.*—The treatment consists in finding the cause, if possible, and attempting to remove it. When this is impossible, large doses of bromide of potassium, alone or combined with hydrobromic acid, will be found most efficacious. Next, quinine in large doses, but this must be carefully watched; and lastly, the use of the continuous current of electricity.

TINNITUS AURIUM arises under most varied conditions. The sounds complained of are very numerous, but may be divided into ringing, rushing, bubbling, and pulsating sounds. Any abnormal condition of the auditory apparatus will produce it, such as—1, accumulations of wax pressing on the drum-membrane; 2, increased intra-labyrinthine tension, from undue pressure on the fenestræ (either by fluid in the tympanum, or retraction of the membrana tympani through obstruction of the Eustachian tube); or lastly, hyperæmia of, or pathological change in, the labyrinth. But in addition to these local causes tinnitus may be produced by causes acting at a distance, such as anæmia, chlorosis, pulsating exophthalmos, aneurysm of the vertebral artery, cerebral disease, large doses of quinine, or salicin. *Treatment.*—In every case it is important, if possible, to ascertain whether the cause is to be found in some derangement of the auditory apparatus, or elsewhere. If the cause be local, it is generally possible to relieve or cure the tinnitus by curing the local affection. If the tinnitus depends on general anæmia, some form of iron, with a generous diet and the addition of stimulants may be sufficient to effect a cure. If there be hyperæsthesia of the nervous system, the bromides are indicated, with the addition of hydrobromic acid, if the singing is of a pulsating character. Tinnitus frequently occurs in patients of a rheumatic diathesis, and in such, anti-rheumatic treatment is, of course, indicated. Other remedies failing, the surgeon, empirically, may try chloride of ammonium, nitrite of soda, and lastly, the continuous current of electricity.

DISEASES OF THE EYE.

By WALTER H. JESSOP, M.B., F.R.C.S., Ophthalmic Surgeon to St. Bartholomew's Hospital.

PHYSICAL EXAMINATION OF THE EYE.—For the complete and thorough examination of the eye it is necessary that it should be examined:—(1) by the unaided eye with or without focal illumination; (2) by the ophthalmoscope; (3) for acuteness of vision, fields of vision, colour sense, and tension. In all cases where practicable each observation on the one eye should be repeated on the other for comparison.

(1.) *Examination by the unaided eye with or without focal illumination.*—Seating the patient in front of a window, or in a dark room with the lamp to the left and about two feet in front of him, direct and concentrate the light on his eye by a biconvex lens of about 2½ inches focal length (*focal illumination*). First look at the *lids*, and tell him to open and shut them; then, with the lids open, to execute the various complete in, out, down and up movements of the eye to test the extrinsic ocular muscles. Along the edges of the lids look for the puncta which ought to be applied close to the ocular conjunctiva. Press near the inner canthus over the lachrymal sac to see if any discharge passes through the puncta. Evert the upper lid to examine its conjunctival surface by directing the patient to look down to the ground, laying a probe horizontally on the external surface of the lid and then taking hold of the lashes turn the lid over the probe. Pull down the lower lid to examine its conjunctival surface.

The ocular *conjunctiva* should be transparent-looking and a few small vessels should be seen through it perforating the white or bluish sclerotic. Just external to the inner canthus is a small greyish-red projection, the *caruncle*, and extending from it a pinkish fold, the *plica semilunaris*.

The vessels seen in inflammations of the eye may be divided into the following:—1. The *posterior conjunctival*. These are generally scarlet or brick-red in colour, tortuous, moveable with the conjunctiva, and do not disappear on pressure. 2. The *sub-conjunctival* are branches or radicles of the anterior ciliary vessels and are divided into the *perforating* and the *episcleral*. The *perforating* arteries stop about $\frac{1}{10}$ inch from the corneal margin, and are well seen in glaucoma; the *episcleral* arteries form a pink zone of straight parallel vessels (*circumcorneal zone*) disappearing on pressure, and are well marked in iritis and keratitis; the *episcleral veins* are dark, dusky-looking, often in limited patches, and are found in cyclitis, scleritis, glaucoma, &c. 3. The *anterior conjunctival* vessels are superficial branches of the anterior ciliary. They are bright red in colour, found near the corneal margin, and indicate superficial corneal mischief.

Next examine the *cornea*, the depth and contents of the anterior chamber, and the *iris* as to its colour, polish and pupillary aperture.

The normal *pupil* is from 3·5 to 5 mm. in diameter, circular, regular, slightly to the nasal side of the centre of the cornea, and equal to and varying with its fellow under different degrees of illumination. The pupil should contract:—on light being thrown into the same eye (*direct light reflex*), on light being thrown into the opposite eye (*consensual light reflex*), and on accommodation or on the convergent movements of the eye associated with accommodation (*accommodation reflex*). It should dilate on one or both eyes being shaded, and also on stimulation of a sensory nerve (*sensory reflex*). Atropine and homatropine produce a dilated pupil (*mydriasis*) inactive to any of the reflexes; cocaine causes mydriasis, but the pupil still acts to the contraction reflexes; eserine and pilocarpine produce a contracted pupil (*miosis*) always dilating slightly on shading or on relaxation of accommodation. The pupil is influenced by the blood supply, and if there is congestion of the iris it is contracted (*congestion-miosis*).

(2.) *Examination with the ophthalmoscope.*—The ophthalmoscope in its simplest form consists of a silvered glass concave mirror of about 20 centimetres focal length, with a central aperture (*sight hole*) of 3 millimetres diameter, fitted on a suitable handle. If required for estimating refraction, lenses are arranged to pass behind the sight hole. The examinations are made much easier by dilatation of the patient's pupil; for this purpose homatropine or a mixture of homatropine and cocaine should be dropped into the eye a quarter of an hour before examination. The methods of using the ophthalmoscope may be divided into (*a*) the *direct* and (*b*) the *indirect*.

(*a*) The *direct method* may be employed in two ways, at a distance and close to the patient's eye. (1) *To use the direct method at a distance*, the patient should be sitting with the light at first just above and behind the head, the observer being about two feet away. Throw the reflection of the light from the ophthalmoscope-mirror through the pupil, and observe through the sight hole the pupillary area as a red colour (*red reflex*). On now slowly rotating the mirror horizontally and vertically a shadow is seen if the refraction is abnormal (ametropic), and this shadow moves in the same direction as the mirror in myopia, and in the opposite direction in hypermetropia and in myopia of less than one dioptre (*retinoscopy*). Approaching closer to the patient examine the media, and observe if any objects other than retinal vessels and the optic disk are seen. If so, on telling the patient to move his eye in different directions, these objects, which are usually of a dark colour, will float about if they are in the vitreous. (2) *Direct method close to the patient's eye.*—The lamp should next be moved on a level with the patient's head and on the same side as the eye under examination. On now bringing the ophthalmoscope to about two inches from the patient's cornea, and at the same time relaxing your own accommodation and telling him to look into the far distance and to move his eye about as you direct, inspect the details of the fundus. If the patient or the observer has an error of refraction it is necessary to correct it by a suitable lens behind the sight hole. Now place a lens of nine dioptres behind the sight hole to investigate the vitreous and the posterior part of the lens, and one of twenty dioptres to see the cornea, anterior chamber, iris and anterior part of the lens.

(*b*) The *indirect* method is perhaps easier to a beginner and gives an extensive and rapid view of the fundus, but is not so accurate as to minute details. The light being placed a little above and behind the patient's head, at a distance of 18 inches look through the sight hole, your right eye at the patient's right eye, and *vice versâ*. Tell the patient to look into the far distance (to relax his accommodation) in the same direction as the fingers holding the ophthalmoscope if the disk is to be examined, or at the sight hole if the yellow spot region is to be investigated. After obtaining the red reflex, hold a lens of about $2\frac{1}{2}$ inches focal length between you and the patient and at about $2\frac{1}{2}$ inches from the patient's eye; an inverted view of the fundus will be thus obtained.

The following are the chief details to be observed in the normal fundus. The *optic disk* is greyish-pink, lighter than the rest of the fundus, and nearly circular in shape; its centre appears sometimes stippled (*lamina cribrosa*), and frequently depressed (*physiological cup*) with the retinal vessels dipping into it. The periphery of the disk is usually lighter in colour (*scleral ring*) and often bordered in part by pigment. Occasionally an opaque white striated patch, radiating from the edge of the disk, is seen with its margin gradually thinning out (*opaque nerve fibres*). The rest of the fundus is bright red, with the retinal vessels on it; sometimes the choroidal vessels may be seen plainly as a network and of a lighter colour than the retinal vessels. At the *yellow spot* the choroidal red is generally deeper in colour and there are no visible blood-vessels. The *retinal arteries* are as a rule smaller and lighter in colour than the veins; both usually divide at a short distance from the disk into superior and inferior temporal and nasal branches. The retinal veins can often be seen to pulsate even in health, and by pressing on the eyeball with the finger the arteries can generally be made to pulsate.

(3.) *Acuteness of vision.*—Snellen's test-types are those usually employed for testing vision, and the letters are constructed so as to be seen under the smallest visual angle (5 minutes). *To test for distant vision*, place the patient at 6 metres from the *distant* type, and if his vision be normal, he ought to read the smallest letters, numbered 6 on the types. His vision is then called $\frac{6}{6}$, or 1. If he only reads the top letter it is $\frac{6}{60}$, or $\frac{1}{10}$, and so on in proportion. If the patient is under 45 give him the *reading types* arranged on the same plan, and find out the smallest he can read at the shortest distance, thus finding his near point and accommodation. If he is too blind to see either type hold your fingers before his eye, and measure the greatest distance at which he can count them. If he is unable to see the fingers, shade his eye, and throwing light into it, see if he has perception of light. If a patient has only perception of light, the observer should, by means of the ophthalmoscope-mirror in a dark room, throw light on to the different parts of his fundus (*projection*) to see if all are equally light-percipient.

The *fields of vision* may now be mapped out roughly by the fingers, or by the perimeter for white and colours. Any spots of the field in which the object used is not seen are called *scotomata*. The *colour vision* is usually investigated by coloured wools.

Intra-ocular tension may be estimated by the fingers, or by instruments called tonometers; the former is the usual way, and is effected by directing the patient to look down on the ground, and then palpating the eyeball through the upper lid with both index fingers. Certain degrees of tension have been recognized, the firm, tense, semifluctuating feeling of the normal eye being taken as the mean (*Tn*); these degrees are denoted according to the amount of increased tension + 1, + 2, + 3, or of diminished tension – 1, – 2, – 3.

I. *Diseases of the eyelids and lachrymal apparatus.*

CILIARY BLEPHARITIS (*Tinea tarsi*) is the most common inflammatory affection of the lids; it is usually chronic, and occurs especially in ill-fed, dirty, hypermetropic, or strumous children. The *symptoms* are redness of the ciliary border of the lids, and either an eczematous condition of the border, or more commonly inflammation and vesication of the hair follicles with stunted and misplaced eye-lashes, followed in bad cases by scarring of the edge of the lid, and slight eversion. The best *treatment* is an alkaline lotion, as sodium bicarbonate gr. x. ad f℥j., and zinc or a weak mercurial ointment applied along the edges of the lids night and morning; in severe cases removal of the lashes and painting the borders of the lids with silver nitrate solution is advisable.

The eyelashes may be the seat of the pediculus pubis, giving rise to a condition which may simulate ciliary blepharitis if there has been much irritation.

MEIBOMIAN CYST (*Chalazion*) is the most common form of tarsal tumour, and is due to chronic inflammation of the fundus of a Meibomian gland. It occurs as a small, hard, painless swelling, with the skin of the lid freely moveable over it. On the conjunctival surface of the lid there is usually a bluish-grey discoloured spot, due to thinning of the tissues. A crucial incision should be made through this spot, and the semi-fluid contents evacuated by pressure or by a small spoon. These cysts have no wall, are generally multiple, most common in young adults, and are very prone to suppurate.

Stye (*Hordeolum*) is a localized inflammation of the cellular tissue of the edge of the lid usually about an eyelash, but sometimes in connection with the duct of a Meibomian gland. It gives rise to throbbing pain, accompanied by swelling and œdema of the lid and conjunctiva; it is usually succeeded by other styes, and is due to some derangement of the general health or error of refraction. It quickly disappears on evacuating the pus when present, or on pulling out the faulty lash.

Foreign body beneath the upper lid is frequently met with and gives rise to sharp pain, lachrymation and photophobia. The *treatment* is eversion of the upper lid and removal of the source of irritation.

Symblepharon, or adherence of the palpebral conjunctiva to the ocular conjunctiva or cornea, may occur owing to inflammation following burns, wounds, and ulcerations.

Congenital malformations of the lids are, *ptosis* (drooping of the upper lid), *epicanthus* (a fold of skin stretching across the inner canthus and concealing the caruncle), and *coloboma* (a deficiency of part of the lid).

The muscular system of the lids may be affected by spasm of the orbicularis palpebrarum (*blepharospasm*), paralysis of the orbicularis giving rise to inability to close the eye, and paralysis of the levator palpebræ producing ptosis.

Inversion of the eyelid (*Entropion*) is produced by some affection of the conjunctiva or tarsus, or by spasm of the palpebral portion of the orbicularis muscle. The most frequent result of entropion is *trichiasis* (turning in of the lashes) giving rise to pannus, ulceration of the cornea, &c.

Eversion of the eyelid (*Ectropion*) is due to atrophy of the palpebral portion of the orbicularis muscle, to swelling of the conjunctiva, or to cicatricial contraction. Numerous operations have been planned for ectropion and entropion and the consequent faulty position of the lashes.

The lachrymal apparatus consists of the lachrymal gland and its ducts situated at the upper and external angle of the orbit, and the drainage system, which includes the puncta, canaliculi, lachrymal sac and nasal duct. The *lachrymal gland* may be the seat of acute or chronic inflammation, and may also be affected by hypertrophy, or sarcoma. The chief lachrymal troubles, however, are associated with the drainage system, and the most marked symptom is that of watery eye (*epiphora*). The *puncta* may be everted or inverted by changes in the lid, or contracted from inflammation. The *canaliculi* may be narrowed by inflammatory hanges or cicatrization after injury, or obstructed by cilia and oncretions. The entrance of the canaliculi into the sac is a very ommon place for stenosis. The *lachrymal sac* may be affected by inflammation spreading from the conjunctival or nasal mucous membrane. This may be accompanied by stricture of the nasal duct, and sometimes gives rise to a collection of mucus in the sac (*mucocele*), which presents as a fluctuating swelling near the inner canthus. On pressing over the swelling the fluid can usually be forced out through the puncta. A *lachrymal abscess* often follows a mucocele; the symptoms are then tense swelling and redness of the integument in the neighbourhood of the lachrymal sac. The *treatment* for stenosis of the puncta or canaliculi is to employ probes or electrolysis, and if these methods fail, to slit up the lower canaliculus by a Weber's knife, removing a piece of the conjunctiva from the inner side of the incision with scissors. For stenosis of the nasal duct probes should be passed to dilate it, and in many cases the use of styles for some time is advisable. In acute inflammation of the sac an incision should be made from the outside through the swelling, or the lower canaliculus should be slit up, and the pus, if found, evacuated that way; the sac should afterwards be syringed with antiseptic or astringent solutions.

II. *Diseases of the conjunctiva.*

CONJUNCTIVITIS (*Ophthalmia*), or inflammation of the conjunctiva, is characterized by a feeling of grittiness, heat, and heaviness of the lids, which tend to stick together especially at night, injection of and small hæmorrhages from the posterior conjunctival vessels, and generally discharge from the eye.

1. CATARRHAL (*muco-purulent*) CONJUNCTIVITIS may be acute or chronic; it presents the usual symptoms of conjunctivitis (see above), and is often accompanied by more or less muco-purulent discharge. It occurs in epidemics, and if there is much discharge, is contagious. There is often marked enlargement of the conjunctival follicles, especially of the lower lid (*follicular conjunctivitis*). Occasionally the discharge is more plastic in nature, adhering to the lids (*membraneous conjunctivitis*). It is best treated by slight astringents (sulphate of zinc, gr. ii. ad f℥j.), or antiseptic lotions, as boracic acid (gr. x. ad f℥j.), and by ointments placed along the edges of the lids to prevent their sticking together. In chronic cases the refraction should always be tested, as refraction-errors, especially hypermetropia, may produce this condition.

2. PURULENT CONJUNCTIVITIS is an acute affection characterized by the severity and rapidity of its onset. It is microbic in origin, and the specific organism is always the gonococcus. It may be conveniently divided into two classes:—

I. *Adult Purulent Conjunctivitis* (*Gonorrhœal Ophthalmia*), the more serious affection, is due to actual contagion with the virus, and usually first affects only one eye. The period of incubation may be only a few hours. The lids at first are red and œdematous; the conjunctiva is much swollen and infiltrated with serum (*chemosis*), and the discharge is serous in nature. After two or three days the serous discharge changes to a very copious discharge of thick pus. The great danger, if the condition is not soon relieved by energetic treatment, is infiltration of the cornea, giving rise to a perforating ulcer and subsequent loss of the eye for useful vision.

II. *Infantile Purulent Conjunctivitis* (*Ophthalmia neonatorum*) occurs in newborn children generally on the third day after birth. It affects as a rule both eyes, and is due to inoculation from the vaginal discharges of the mother; to avoid this risk every child's eyes should be thoroughly washed immediately after birth with an antiseptic solution (silver nitrate, gr. ii. ad f℥j.). The symptoms are similar but not so severe as in the adult, and the cornea is not so likely to become involved. *The chief complications* are corneal ulcers, leukoma adherens, anterior polar cataract, and panophthalmitis followed by shrinking of the globe.

The *treatment* must be directed chiefly to washing away the discharge. For this purpose the eye should be thoroughly syringed or washed with a lotion of corrosive sublimate (1 to 6,000) or of weak nitrate of silver every hour during the day, and as frequently as possible at night, being careful to allow sufficient sleep. The lid should be everted once a day if possible and painted with silver nitrate solution (gr. x. to ℥j.) and, if practicable, ice-pads applied to the lids. This treatment should be continued as long as the discharge continues purulent. Ulceration of the cornea should be treated energetically by the actual cautery or solid nitrate of silver. If only one eye is affected, the rule in the adult, the opposite eye should be covered if possible by a watch-glass shade to prevent inoculation.

3. MEMBRANEOUS (*diphtheritic*) CONJUNCTIVITIS is the most serious and virulent form of ophthalmia, and an eye may be destroyed by it in twenty-four hours. It is marked by great pain and excessive browniness and stiffness of the lids owing to the plastic infiltration of the mucous and submucous surfaces. The palpebral conjunctiva is covered by a smooth grey membrane, and if this is stripped off, the surface still remains grey. The membrane lasts from 6 to 10 days, and is then followed by purulent conjunctivitis. *Treatment.*—At first antiseptic lotions and warm fomentations, and then the usual treatment for purulent conjunctivitis. In two cases lately under my care the membrane rapidly disappeared, without being followed by purulent conjunctivitis after the subcutaneous injection of diphtheria antitoxin.

4. GRANULAR CONJUNCTIVITIS (*Trachoma*) derives its name from

the presence on the palpebral conjunctiva, especially near the fornix of the upper lid, of greyish raised bodies about the size of a pin's head. It may be acute or chronic, and occurs at all ages except in very young children. It is especially common in those subjected to bad hygienic surroundings; hence its frequency in insanitary schools, marshy districts, and overcrowded camps. *The acute* form is rare in England and is accompanied usually by a muco-purulent discharge which generally absorbs the granulations and so cures the disease. In the *chronic form* the *symptoms* are a heavy look of the lids, irritable eyes, and at times a muco-purulent discharge. The muco-purulent discharge depends more upon the condition of the conjunctiva than on the presence of the granulations. The disease is probably only contagious during the continuance of the discharge. The granulations often affect the submucous tissue, giving rise to scarring. *Pathology.*—There are two views as to the nature of the granules: 1. That they are due to hypertrophy of the lymph-follicles of the conjunctiva; and, 2, that they are new growths. The disease is believed by some to depend upon the presence of a specific micro-organism. It may be *complicated* by pannus, ulcers of the cornea, entropion, trichiasis, &c. *Treatment.*—In the acute form antiseptic lotions should be employed. In the chronic form, with muco-purulent discharge, paint the inside of the lids once a day with silver nitrate solution (gr. x. to ℥j.), and order an astringent lotion, as zinc sulphate (gr. ii. to ℥j.), to be dropped into the eye two or three times a day. If there be no discharge, touch the granulations lightly two or three times a week with a crystal of copper sulphate. During the discharge stage the patient should be isolated.

5. PHLYCTENULAR CONJUNCTIVITIS is met with very frequently, and is characterized by the presence on the ocular conjunctiva or on the anterior surface of the cornea of one or more papules or pustules surrounded by a limited vascular zone. It is extremely common in young children, especially if strumous. Photophobia or lid-spasm may be present. The *treatment* is chiefly dietetic with the local application of yellow mercuric oxide ointment (gr. iv. ad ℥j.).

PINGUECULA is a yellowish elevation, not containing fat, of thickened conjunctiva and subconjunctival tissue near the inner or outer edge of the cornea.

PTERYGIUM is a triangular thickened piece of the ocular conjunctiva, with its apex at the margin of or on the cornea. It is especially found in people who have been in the tropics. If it invades the cornea to any great extent it may be dissected off and the apex stitched back on the conjunctiva.

Wounds of the conjunctiva heal well, and if extensive ought to be stitched up.

III. *Diseases of the cornea and sclerotic.*

Keratitis, or inflammation of the cornea, is characterized, as a rule, by pain, photophobia, lachrymation, impairment of vision, pink circumcorneal vascular zone, and want of natural transparency of the cornea. It may be divided by its position into 1, superficial; 2, interstitial; and 3, posterior or punctate.

1. Superficial keratitis is usually produced by irritation due to roughness or insufficient protection of the lids. The condition is often vascular (*pannus*). A very painful form is accompanied by numerous small vesicles (*herpes of the cornea*). The *treatment* consists in the removal of the irritant, and in the application of sedative lotions of opium, belladonna, &c. In obstinate cases of pannus the operation of *peritomy* (removal of a ring of conjunctiva round the corneal periphery so as to cut off the superficial blood supply to the cornea) may be performed.

Corneal ulcer is a loss of substance due to limited inflammation of the corneal tissue. It is described here under superficial keratitis because it usually begins in the superficial or epithelial part of the cornea. Sometimes from the commencement it affects the corneal tissue proper, and is then generally produced by a limited collection of pus in the lamellæ of the cornea (*abscess or onyx*). A corneal ulcer may be (*a*) simple, or (*b*) infective, and in either case may be central or peripheral, acute or chronic.

(*a*) The *simple ulcer* may be due to a phlyctenule, injury, or other cause, and is best treated when acute by atropine drops, unless it be deep and peripheral, when eserine or pilocarpine drops are to be preferred. When chronic, an ointment of yellow mercuric oxide (gr. ij.—xv. to vaseline ℥j.) should be placed in the eye once or twice a day, and massage employed to the surface of the closed lid.

(*b*) The *infective ulcer* tends to spread rapidly at its edges and also in depth; it is often accompanied by *hypopyon* (pus in the anterior chamber) and then is generally microbic in origin. The best *treatment* is the actual cautery or solid nitrate of silver applied to the edges and base; the evacuation of the pus in an adult by tapping the anterior chamber from below; and the local application of belladonna or atropine.

2. Interstitial keratitis is usually associated with congenital syphilis, sometimes with struma, and occasionally with acquired syphilis. The whole cornea undergoes a subacute or chronic nflammation; it at first looks steamy and then patchy and like ground glass; the patches usually become vascular (*salmon patches*), but there is no tendency as a rule to superficial ulceration or suppuration. After some months the eye begins to clear up under

treatment even in very bad and apparently hopeless cases. Though as a rule one eye is attacked first, the other after a few weeks or months generally becomes affected. The usual age is between five and sixteen. The attendant *complications* are iritis, secondary glaucoma, uveitis, and in very bad cases shrinking of the eyeball. After an attack there are to be found generally nebulæ in the cornea and always the remains, at the corneal periphery, of the vessels of inflammation. The *treatment* is the administration of small doses of mercury over a long period, or iron tonics, and locally atropine and yellow oxide of mercury ointment.

3. Keratitis punctata is probably never present without disease of the uveal tract (page 504). It is characterized by the presence of dots of different sizes on the epithelium of Descemet's membrane. These are generally arranged in the lower half of the cornea in the shape of a conical bullet with the apex upwards. The dots may be proliferations of the posterior corneal epithelial cells, or granules deposited on the epithelium lining Descemet's membrane.

The *results* of keratitis are often to be found in the corneal tissue as small branching lines (remains of vessels), greyish opacities (*nebulæ*), and dense opaque white patches (*leukomata*). The use of lead lotion in keratitis is especially prone to give rise to leukomata, and should therefore never be used in this disease. In cases of perforating ulcer, the iris may become adherent to the cornea, a condition known as *anterior synechia*, or if the corneal scar is white, as *leukoma adherens*. The other results which may occur are conical cornea, and bulging of the cornea and sclerotic (*anterior staphyloma*).

Conical cornea (*keratoconus*) is a bulging of the central portion of the cornea. It generally occurs in females, and is due to defective nutrition of the corneal tissue. It may follow an ulcer, especially if central. Operative procedures, as iridectomy, trephining the cornea, or paracentesis, rarely do any good. The vision may be improved by concave or stenopaic glasses.

Foreign bodies on the cornea should be removed as soon as possible. Anæsthesia of the cornea should first be obtained by dropping 4 % cocaine solution three times into the eye at intervals of five minutes. The patient being seated in a chair facing the light, the operator stands behind the patient and with the fingers of the left hand separates the lids, at the same time pressing on the eyeball to steady it. Then with a spud or needle held in the right hand the foreign body should be lifted off or picked out of the corneal tissue.

Scleritis (*episcleritis*) or inflammation of the scleral tissue, is accompanied by a circumscribed reddish-purple patch of vascular congestion about 2 to 3 mm. from the corneal margin, generally on the outer side. It may last for some months, and often relapses; the pain and tenderness vary much in intensity, and in severe cases keratitis and iritis may be present. It is more common in women than men, and affects especially those of the rheumatic and strumous diathesis, or patients with a syphilitic taint. The best modes of *treatment* are warm fomentations of opium, leeches, massage, belladonna and atropine if iritis is suspected, and general constitutional remedies.

WOUNDS of this region may be divided into (*a*) corneal, (*b*) scleral, and (*c*) sclero-corneal. (*a*) *Corneal wounds*, unless implicating the lens or iris, generally heal quickly. (*b*) *Scleral wounds* more than $\frac{1}{4}$ inch behind the sclero-corneal junction, if small and unaccompanied by the presence of a foreign body in the eye, may be stitched up, or the conjunctiva stitched over them, and then treated by ice-pads to allay inflammation. (*c*) *Sclero-corneal wounds* are the most dangerous, owing to the great risk of sympathetic inflammation, and demand great judgment in saving the eye; in most cases the eye ought to be excised, especially if the lens is injured.

IV. *Diseases of the uveal tract.*

THE UVEAL TRACT comprises the iris, ciliary body and choroid, and though disease may be limited to one part, there is always a tendency for it to spread through the whole tract.

IRITIS OR INFLAMMATION OF THE IRIS may be acute, subacute, or chronic. The usual *symptoms* of a case of acute or subacute iritis are—pain and tenderness along the ophthalmic division of the fifth nerve, dimness of sight, lachrymation, injection of the episcleral vessels giving rise to a pink circumcorneal zone, and occasionally photophobia. The iris is dull, and discoloured, *e.g.* a blue iris becomes green, the pupil is sluggish, contracted, generally irregular owing to adhesions to the anterior capsule of the lens (*posterior synechiæ*), and acts badly or not at all to atropine. In chronic iritis there may be no symptoms except irregularity of pupil, dimness of vision, and at times pain. Iritis is especially likely to occur in patients suffering from syphilis, rheumatism, or gout; it may also have a traumatic origin, or be secondary to inflammations of the cornea, sclerotic, or the other parts of the uveal tract. The iritis associated with *syphilis* is often symmetrical, and generally accompanied by great effusion of lymph in the neighbourhood of the pupil. Iritis in *rheumatic* patients is usually very painful, and differs as a rule from the syphilitic variety in its great tendency to recur. It is especially liable to attack those of the rheumatic diathesis if suffering from prolonged gonorrhœal discharge. In *gouty* subjects there may be a very insidious form (*quiet iritis*). The *local treatment* is first directed to obtaining dilatation of the pupil by atropine or atropine and cocaine combined; if there is much congestion of the conjunctival vessels and pain, it is well to apply one or two leeches or a small blister to the temporal region about one inch from the external canthus. The *general treatment* is that applicable to the diathesis of the patient, but a mild course of mercury is by some always prescribed in acute iritis.

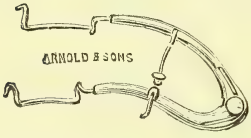


Fig. 238.—Spring eye-speculum.

The chief traumatic affections of the iris are blood in the anterior chamber (*hyphæma*), mydriasis (due to paralysis of the sphincter pupillæ), tremulous iris (generally due to dislocation of the lens), rupture of the ciliary border of the iris (*coredialysis*), a rent in the pupillary border, and prolapse of the iris after a perforating wound.

The congenital abnormalities are difference in colour in both irides, irregularity in shape and position of pupil, multiple pupils (*polycoria*), remains of pupillary membrane, deficiency of part of iris (*coloboma*), and absence of iris (*irideremia*). In coloboma the deficiency is generally downwards and inwards, and is often combined with a similar condition of the choroid.

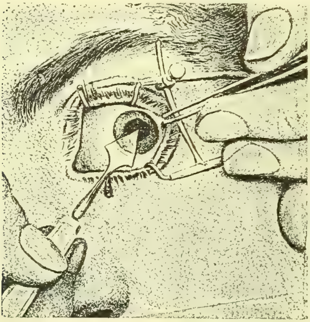


Fig. 239.—Showing speculum in eye, fixation-forceps in position, and the keratome passed into the anterior chamber in the operation of iridectomy downwards and inwards.

Iridectomy.—This operation may be performed (*a*) to improve the sight in cases of corneal opacity, anterior polar cataract and lamellar cataract, (*b*) as a remedial measure in glaucoma, relapsing iritis, and complete posterior synechia, and (*c*) in cataract extraction.

Operation.—Place the patient in a recumbent posture and induce general anæsthesia, preferably by chloroform, or local anæsthesia, by means of cocaine (4%). Standing behind the patient's head introduce the spring speculum (Fig. 238); fix the conjunctiva near the cornea with fixation-forceps opposite the place selected for the coloboma. Pass the keratome by pressure perpendicularly through the cornea (Fig. 239), and then lowering its handle press the blade into the anterior chamber parallel to the iris; now lower the handle still more till the point nearly touches the posterior surface of the cornea and then slowly withdraw the keratome. Give the fixation-forceps to an assistant to gently depress the eye; pass through the wound the iridectomy forceps closed with the points directed towards the posterior surface of the cornea, open the forceps, seize the pupillary border of the iris, slowly draw it out, and snip it off with the scissors either parallel to the wound, or at right angles to the wound across the cornea. Carefully return the edges of the coloboma with a curette (Fig. 240), and bandage up the eye. In iridectomy for glaucoma it is the rule to make a large corneal incision (most operators preferring a Graefe's knife), and to remove the iris up to the ciliary border.

CYCLITIS, or inflammation of the ciliary body, rarely occurs without other parts of the uveal tract being involved. The *symptoms* are circumcorneal zone of redness, pain and tenderness in the ciliary region, pain on accommodating, and often hypopyon and vitreous opacities. It is best *treated* by atropine and leeches.

CHOROIDITIS, except as part of a more general inflammation, is rarely accompanied by external signs or severe pain. *Ophthalmoscopically* there may be, if recent, soft yellowish-white exudation patches either at the yellow spot or elsewhere; these patches on clearing up leave as a rule atrophy of the choroid, showing the white sclerotic through, with the edges bordered by disturbance of pigment. The atrophic patches may be ringed, diffused, or punctate, and if due to hæmorrhage from the choroidal vessels are generally large and deeply pigmented. The retinal vessels always pass over these patches of choroiditis. Vision is as a rule diminished, but not always. The usual causes are syphilis (acquired and congenital), myopia, tubercle and hæmorrhages. In syphilitic cases mercurial treatment should be continued for a lengthened period.

FIG. 240.—Curette.

UVEITIS, or general inflammation of the uveal tract, commonly starts in the ciliary body, and is characterized by the chief symptoms of iritis, cyclitis, and choroiditis. It may be divided into (1), purulent, and (2), plastic.

1. PURULENT UVEITIS (*panophthalmitis*) has usually a traumatic origin, but may occur in pyæmia and in old blind eyes. The symptoms are extreme pain, acute congestion and œdema of the lids and conjunctiva, and after a few days, if the media are transparent enough, a yellowish reflex, due, as a rule, to suppuration in the vitreous. The usual course is for the inflammation to affect the whole interior of the eye, and afterwards the extrinsic

muscles and Tenon's capsule. The *treatment* is either immediate enucleation, or incisions into the eyeball to allow free vent to the pus. Meningitis has occasionally followed enucleation in these cases.

2. PLASTIC UVEITIS is characterized by a great tendency to deposition of lymph, and may be divided into Acute and Chronic.

(*a*) *Acute plastic uveitis* (*Sympathetic Inflammation* or *Sympathetic Ophthalmia*) is set up in one eye by morbid changes usually the result of a wound of the other eye. The injured eye is called the "exciting," and the other the "sympathizing eye." It occurs usually from six weeks to three months after injury. It is preceded as a rule by a condition known as "Sympathetic Irritation," characterized by lachrymation, photophobia, dimness of sight, oscillations of the pupil and frontal neuralgia. The *symptoms* are impaired vision, circumcorneal zone, keratitis punctata, deep anterior chamber, iritis, papillo-retinitis, and opacities in the vitreous. These symptoms are followed by thickening and vascularization of the iris, occlusion of the pupil by lymph, shallow anterior chamber, diminished tension, shrinking of the vitreous, detachment of the retina, &c. The prognosis is very unfavourable, as only in a few cases the changes stop short of actual loss of the eye for useful vision, and it must always be remembered that the *sympathizing* eye suffers as a rule more severely than the *exciting*. The nature of the disease is probably a microbic inflammation spreading from the exciting eye by the optic nerves and chiasma to the sympathizing eye. The *treatment* consists in confinement to a dark room, goggles, atropine, leeches and mercury. If the exciting eye is quite blind it should be excised, but if it has useful vision it should be saved.

(*b*) *Chronic plastic uveitis* occurs as a rule in strumous and syphilitic patients. The disease progresses like "Sympathetic Inflammation," but is more chronic; it usually affects both eyes at intervals, and often passes on to complete blindness. In young children plastic uveitis may produce a condition called "*pseudo-glioma*," which may be diagnosed as a rule from glioma by discoloration and adhesion of the iris, minus tension, &c. A less severe and more common form of chronic plastic uveitis may be called *Anterior Uveitis* (*serous iritis*) from its affecting the anterior part of the uveal tract. It is characterized by keratitis punctata (page 500), deep anterior chamber, often dilatation of the pupil, increased tension, and the usual symptoms of iritis and cyclitis, accompanied frequently by a few peripheral choroidal changes, and small vitreous opacities. It is generally found in young adults, especially women, and is often associated with gout, rheumatism, and struma. The *treatment* is complete rest for the eyes, and atropine drops with careful watching of tension.

The *Uveal tract* may be affected in any part by sarcoma (generally melanotic), the usual primary ocular seat of sarcoma being the ciliary body or the choroid.

V. *Diseases of the crystalline lens.*

CATARACT is the name applied to an opacity, complete or partial, of the lens or capsule, and is due to structural changes. Cataracts may be divided into *hard* or *soft*, according to their consistency, and this usually depends on age, as below thirty-five they are all "soft." They are called *primary* when independent of any other ocular affection, and *secondary* when following some other disease, as glaucoma, intra-ocular tumour, &c. Though all cataracts at first are incomplete or partial, yet it is advisable to make a division into (1) complete (including those that in time tend to become complete), and (2) partial (those that do not, as a rule, tend to become complete).

(1) COMPLETE CATARACTS are usually senile or hard, and are called, according to their seat of origin, nuclear or cortical. Nuclear cataracts are characterized by an opacity at the nucleus of the lens; they are often amber in colour and mostly hard, except sometimes in diabetes; cortical cataracts, which are the more common, begin as flakes or streaks radiating from the axis of the lens. Congenital cataract may occur as a general opacity of the lens; and it is usually binocular. A complete cataract may degenerate and its cortex become fluid (*Morgagnian Cataract*).

(2) PARTIAL CATARACTS include (*a*) lamellar, (*b*) anterior polar, and (*c*) posterior polar.

(*a*) *Lamellar (zonular) cataract* is either congenital or forms in early life; it is generally associated with a history of infantile convulsions, and with a deficiency of the enamel of the teeth. The opacity is situated as a shell between the nucleus and cortex, which are both clear. It is usually symmetrical.

(*b*) *Anterior polar (pyramidal) cataract* is a small dense white central opacity on the anterior capsule of the lens, often due to perforation of the cornea in early life, and as a rule associated with corneal nebula.

(*c*) *Posterior polar cataract* is situated at the posterior pole of the lens. The opacity is generally in radiating spokes, and is often accompanied by disease of the vitreous or choroid.

Diagnosis.—When a cataract is complete it looks white, amber, or grey, and may be seen best by dilating the pupil, and examining by focal light. When incomplete and cortical the striæ may be seen by oblique illumination if the pupil is dilated, or by throwing light into the eye by the ophthalmoscopic mirror (preferably a plane mirror), when the striæ will appear as black lines.

The *subjective symptoms* in incipient cataract are failing vision, black fixed spots or lines before the eyes, ability to see better in the dark due to dilatation of the pupil, myopia, and sometimes monocular diplopia or polyopia.

Treatment.—In incipient senile cataract, especially of the nuclear variety, weak atropine (gr. ½ to gr. j. to ℥j.) drops will often temporarily improve the sight, and may be ordered with caution.

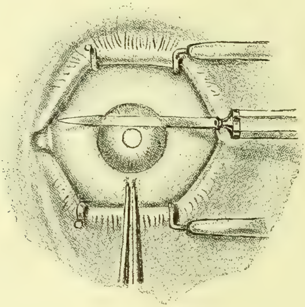


Fig. 241.—Showing speculum in eye, fixation-forceps, and Graefe's knife in position for performing flap section in cataract extraction. The line of flap is also shown dotted.

The operations for removal of the lens are of two kinds, namely (*a*) *extraction*, and (*b*) *discission*; extraction is always preferable in hard cataracts, and sometimes in soft, especially in adults. It is of course necessary before proceeding to operation that the condition of the eye be satisfactory as far as the lids, conjunctiva and lachrymal apparatus are concerned, and that there is good perception and projection of light. The tests for the perception and projection of light should never be omitted, since, if the eye is blind or the fundus is seriously diseased, the removal of the cataract would be useless and unjustifiable. In senile cataract it is usual to wait till the vision of one eye is reduced to mere perception of light, and the vision of the other is insufficient to allow the patient to follow his occupation. The general health of the patient must also be investigated, as senile cataract may be associated with gout, glycosuria, albuminuria, and arterial disease.

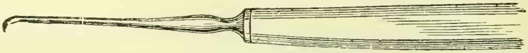


Fig. 242.—Cystitome.

(*a*) The *extraction operations* are numerous, but the only one described here will be the 3 millimetre flap operation, which may be performed with or without iridectomy.

Operation.—The first steps are as in operation for iridectomy (see p. 502). After the introduction of the spring speculum, fix the eye by seizing the conjunctiva with fixation forceps immediately beneath the cornea, pass the point of a Graefe's knife through the margin of the cornea at the outer extremity of a horizontal line 3 millimetres beneath the summit of the cornea (Fig. 241), and direct it carefully across the anterior chamber to the inner corneal end of the above horizontal line; complete the incision in the corneal margin above by slow to and fro upward movements of the knife. An iridectomy upwards is now performed if required (see p. 502). Fixing the eye, pass a cystitome (Fig. 242) through the wound and divide the anterior capsule of the lens by horizontal incisions. Draw the eye now slightly downwards, and apply moderate pressure by a curette (Fig. 240) or spoon below the lower border of the cornea till the upper edge of the lens presents in the wound (see Fig. 243) and the lens is gradually delivered. The speculum may now be removed and the lids closed for a brief time, after which any soft matter is extracted by pressure applied to the lower surface of the cornea with a curette. The iris is now carefully replaced by the curette, and both eyes bandaged up. The after-treatment consists in keeping the eyes bandaged for about a week, removing the bandages and washing the lids gently every day. If there are

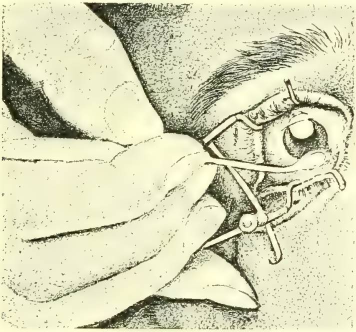


FIG. 243.—Showing the lens presenting in the wound from pressure by the spoon during the operation of extraction.

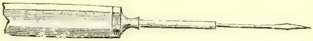


FIG. 244.—Stop-needle.

any signs of iritis, characterized by pain and swelling of the lids, atropine and leeches must be prescribed; if the corneal wound suppurates it should be cauterized or dusted with iodoform. The other complications are prolapse of the iris, intraocular hæmorrhage and panophthalmitis. After two months the vision should be tried for glasses, and if there is much membrane left in the pupillary area, producing unsatisfactory vision, a *secondary operation* must be performed. This is done, the eye being under atropine and cocaine, by passing a needle (Fig. 244) through the periphery of the cornea and breaking up the membrane.

(*b*) The *discission or needling operation for soft cataract.*—Place the patient in the recumbent position and induce local anæsthesia by cocaine, or if the patient be nervous or a young child give chloroform. The pupil must be fully dilated beforehand by atropine. Standing behind the patient's head, introduce the spring speculum (Fig. 238), fix the globe, and pass a sharp, straight stop-needle (Fig. 244) through the periphery of the cornea into the anterior chamber. Push the needle firmly but gently till it touches the anterior capsule of the lens near its centre, and by a crucial incision lacerate the capsule of the lens. Now slowly withdraw the needle, put atropine in the eye, and apply a bandage. The effect of this operation, which may have to be repeated, is that the lens-matter passes into the anterior chamber, and is softened by the aqueous and absorbed. Occasionally in young children repeated needlings may produce absorption of the whole lens. As a rule, however, after a week or ten days the soft matter must be evacuated, especially if it produces much irritation or increased tension. This is done by making an incision in the lower part of the cornea by a keratome (Fig. 239), as in the first steps of an iridectomy operation (p. 502). After the corneal incision has been made and the keratome withdrawn, a curette (Fig. 240) should be introduced through the corneal wound, and by manipulating the curette the soft matter passes out along its groove and can be removed. Care must be taken on completion of the operation that the iris is not caught in the edges of the wound.

The CHIEF INJURIES of the lens are (1) traumatic cataract due to rupture of the capsule, and (2) dislocations of the lens usually downwards but sometimes into the anterior or posterior chambers.

VI. *Diseases of the optic nerve, retina, and vitreous.*

The optic nerve fibres may be divided into two sets, *axial* (for the supply of the yellow spot region) and *peripheral* (for the rest of the retina).

OPTIC NEURITIS, or inflammation of the optic nerve, may be acute or chronic, and attack the whole or part of the fibres of the nerve; and may be divided into (1) *papillitis* affecting the intra-ocular end of the nerve, and (2) *retro-bulbar neuritis* affecting the nerve behind the globe.

1. PAPILLITIS usually affects both eyes except when due to orbital mischief. The *signs*, chiefly ophthalmoscopic, are hyperæmia, swelling and haziness of the edges of the disk, distended and tortuous retinal veins, and small or normal retinal arteries. In extreme cases the retina is much involved (*papillo-retinitis*), the distended veins being covered in part by greyish-white striæ or opacities, and the retina itself œdematous with flame-shaped hæmorrhages often radiating from the disk. The vision may be normal or much reduced, and the field for vision is usually peripherally limited. The chief *causes* are cerebral tumours, cerebral abscess, tubercular meningitis, and nephritis, also orbital inflammations, acute myelitis, syphilis, chlorosis, and lead poisoning. The *treatment* is chiefly constitutional, but in uni-ocular papillitis incision into the nerve-sheath has by some been recommended.

2. RETRO-BULBAR NEURITIS may occur in one eye, due to orbital periostitis, &c., without at first any ophthalmoscopic signs, the only symptoms being loss of sight and generally pain on movement of the eye. There is usually a central scotoma. As a rule symptoms of optic atrophy follow.

Chronic retro-bulbar neuritis (*toxic amblyopia*), generally affecting both eyes, is an inflammation of the axial fibres, and is found in persons using excess of tobacco or alcohol, and perhaps in diabetes. The symptoms are diminution of vision usually of both eyes, the fields of vision being normal as to their periphery, but containing a central *scotoma* (blind spot) for red and green. By the ophthalmoscope the only change to be seen in most cases is slight pallor of the temporal side of the optic disk. The patients complain of mist before the eyes, and of confusing gold and silver coins; they generally exhibit want of tone. The *treatment* is directed to improve the general health, and to avoid the exciting cause.

ATROPHY OF THE OPTIC NERVE may be a primary disese, or secondary to some other optic nerve or retinal affection. By the ophthalmoscope the optic disk is white or greyish, often slightly cupped or filled up; the lamina cribrosa is too plainly visible; the retinal vessels, especially the arteries, are too small; the vessels may be accompanied by white streaks on each side; and if there has been previous papillitis, the vessels are curved antero-posteriorly and often obscured in places; the scleral ring round the disk is too white and the edges of the disk may be irregular. Atrophy may follow papillitis, retro-bulbar neuritis, embolism of the central artery of the retina, retinitis (especially pigmentary), and glaucoma. A form called *progressive atrophy* is found in locomotor ataxia, insular sclerosis, general paralysis of the insane, and as a purely local disease; it is marked by concentric contraction of the fields of vision, loss of sight, colour blindness, and sometimes central scotoma, and as its name implies progresses to complete blindness. The treatment is generally the administration of anti-syphilitic remedies, hypodermic injections of strychnia, and galvanism, but the prognosis is as a rule very bad.

RETINITIS, or inflammation of the retina, is usually accompanied by diminution of vision, especially at night or in dim lights and is characterized *ophthalmoscopically* by loss of transparency and haze of the fundus; soft white discrete or grouped spots; hæmorrhages of various sizes and shapes (striated or flame-shaped in nerve-fibre layer), and by vitreous opacities. Retinitis is associated with syphilis, nephritis, glycosuria, leukæmia, pyæmia (*purulent retinitis*) and with diseases of the circulatory system (*hæmorrhagic retinitis*). The *treatment* is chiefly constitutional, and the eyes must be shaded and used as little as possible.

RETINITIS PIGMENTOSA is a chronic and symmetrical disease, occurring in early life, characterized by night blindness, and great contraction of the fields of vision, even though the central vision be normal. *Ophthalmoscopically* the optic disk is "waxy-looking" and atrophied, the retinal arteries are small, and there is much lace-work retinal pigment, especially at the equator and periphery. The loss of sight is progressive, and the disease often ends in blindness.

EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA occurs usually on the left side and may be associated with heart disease. Owing to this artery being a terminal one, complete plugging of it is followed by total and sudden blindness. The *ophthalmoscopic* signs are pale optic disk, diffused retinal haze, bright red colour at yellow spot, and retinal arteries near the disk very small and often like white threads. The *treatment* is massage of the eyeball, but the prognosis is bad.

DETACHMENT OF THE RETINA is due to separation of the retina from its pigment epithelium by serous exudation or hæmorrhage. It is accompanied by defect in the field of vision corresponding to the detachment. With the *ophthalmoscope* the detachment looks greyish, and the retinal vessels passing over it are seen to be elevated. The causes are blows on the eye, myopia, cicatrices following wounds, and choroidal tumours. *Treatment*, except complete rest, is usually unavailing.

GLIOMA OF THE RETINA, which has been shown by Collins to be an adenoid cancer and not a sarcoma, occurs in early life, and the first symptom is a shining white or yellow reflex seen behind the pupil; by focal illumination there is found a nodulated swelling, with small vessels and often hæmorrhages on it. The tension may be at first normal or increased, and there may be secondary glaucomatous symptoms, but later the tension may be diminished. The *treatment*, unless the tumour is very large, is immediate excision of the eye and removal of as much of the optic nerve as possible. The *prognosis* is very unfavourable.

VITREOUS OPACITIES are usually due to inflammation (*hyalitis*) associated with diseases of the uveal tract or retina, but often occur in extreme myopia, and from retinal and choroidal hæmorrhages. The opacities may be of different shapes and sizes, and in syphilis are very minute and dust-like. The patient complains of seeing black specks floating before the eyes, and vision is sometimes reduced. Owing to degeneration the vitreous may be fluid, and contain cholesterine crystals.

SUPPURATION OF THE VITREOUS (*suppurative hyalitis*) is due to injury or to extension of a purulent uveitis, and is sometimes called *pseudo-glioma*, from the yellowish fundus-reflex. *Foreign bodies*, as steel, glass, &c., may be found in the vitreous, and, when steel or iron, can be removed by the electro-magnet introduced through the original wound when scleral, or through an incision in the sclerotic.

VII. *Glaucoma.*

GLAUCOMA is a condition of the eye dependent on excess of the ntra-ocular pressure. The chief *symptoms* are increased intraocular tension (elicited by palpating the eyeball with both index ingers through the closed lids); pain and tenderness; enlargement f the perforating vessels; impaired sensibility, steaminess, and itted appearance of the cornea; shallow anterior chamber; dilaation of the pupil; greenish fundus reflex; pulsation of the etinal arteries, and engorgement of the retinal veins; underining and cupping of the optic disk; diminished acuity of vision nd light sense; and limitation of field of vision chiefly at nasal de. These symptoms are generally preceded or accompanied by noky vision (everything seen in a grey or yellow fog), coloured ncentric rings (rainbows) round lights (red outside and bluishreen inside), neuralgia along the branches of the fifth nerve, and pidly increasing presbyopia necessitating frequent changes of asses.

Varieties.—Glaucoma may be divided into (1) acute, (2) subacute, d (3) chronic.

1. *Acute glaucoma* is characterized by the severity and suddenness its onset, and from the vomiting, megrim, &c., accompanying it s often been mistaken for a bilious attack. The steaminess of the nea prevents as a rule any view being obtained of the fundus,

although the pupil is widely dilated. The optic disk when visible is found in first attacks not to be cupped, but there is marked pulsation of the retinal arteries and engorgement of the veins. Such an attack may subside after a few days, but is generally followed by others until the eye may pass into a permanent glaucomatous condition (*absolute glaucoma*) and vision be totally destroyed. Absolute glaucoma is accompanied by great pain and increased tension, intra-ocular hæmorrhages, opacity of the lens, ulceration and staphyloma of the cornea, and shrinking of the whole globe. Some cases of acute glaucoma may be accompanied by severe intra-ocular hæmorrhage (*hæmorrhagic glaucoma*).

2. *Subacute glaucoma* is characterized by the symptoms of glaucoma as given above. There is generally a gradual progress, sometimes with exacerbations, and it may at any time give rise to acute glaucoma.

3. *Chronic glaucoma* may follow on an acute or subacute attack, but there is an insidious and progressive form usually attacking both eyes, in which all irritative signs are absent. Without pain and often with no apparent increase of tension, there is gradual reduction of the amplitude of accommodation, and diminished corneal sensibility, with cupping and progressive atrophy of the optic disks often passing on to absolute blindness.

Pathology.—Glaucoma is produced by any circumstance tending to upset the normal relation of the secretion and excretion of the intra-ocular fluids. These fluids, secreted by the ciliary processes, pass chiefly out at the angle between the iris and the cornea (*iridic or filtration angle*). This increased tension may be produced by hypersecretion of the ciliary processes, obstruction at the filtration angle, or by serosity of the fluids. The most frequent cause is obstruction of the filtration angle due to inflammatory products, or to mechanical means as growth of the lens, or dilatation of the pupil especially by atropine. Glaucoma occurs as a rule in persons over 40 years of age, is frequently hereditary, and is often associated with hypermetropia. It may be *secondary* to complete posterior synechia, perforating ulcers and wounds of the cornea, dislocation of the lens laterally and into the anterior chamber, cataract operations, intra-ocular tumours, and intra-ocular hæmorrhage.

The *treatment of acute glaucoma* is by instillation of eserine (especially if the attack is caused by atropine) or by a large iridectomy, as much as one-fifth of the iris being removed. Several other operations have been recommended, as sclerotomy. In *glaucoma absolutum* puncture of the sclerotic often relieves the pain. In *subacute* cases iridectomy is generally indicated, but in *chronic glaucoma* without tension operative procedure probably does little good.

VIII. *Diseases of the orbit.*

SUBCONJUNCTIVAL HÆMORRHAGE, due to a blow on the eye or to rupture of a small vessel, owing to cough, &c., is of a bright red colour. The blood effusion is more marked anteriorly and does not pass far back. Exactly the converse as to the position of the blood applies to deep orbital hæmorrhage following fracture of the anterior fossa of the skull, &c.

ORBITAL ABSCESS AND ORBITAL CELLULITIS, when acute, are difficult to diagnose from each other. Though often traumatic they may be due to cold, irritation of a tooth, erysipelas or pyæmia. They sometimes originate in periostitis. They are usually characterized by swelling of the lids, chemosis of the conjunctiva, pain on movements of the eye and on pressing back the eyeball, limitation of the ocular movements, facial neuralgia, and proptosis; sometimes there is a defined, tender, fluctuating swelling. If the symptoms are not soon relieved, especially in orbital cellulitis, papillitis and atrophy of the optic nerve may ensue and also meningitis. *Orbital abscess* may be chronic and simulate a solid tumour. The treatment consists in early evacuation of the pus, hot fomentations and constitutional remedies.

TUMOURS OF THE ORBIT usually cause protrusion of the eye (*proptosis*), impairment of its movements, and papillitis or optic atrophy. Generally one orbit only is affected. The origin of an orbital tumour may be *primary*, in the lachrymal gland, in the loose orbital tissues, in the periosteum, in the eyeball or in the optic nerve; or *secondary*, starting from a neighbouring cavity. The *primary tumours* may be cystic (hydatid, dermoid); osseous (ivory exostosis), sarcomatous, and vascular (nævi). Amongst the *secondary tumours* may be mentioned arterio-venous communication in the cavernous sinus giving rise to a pulsating tumour, and distension of the frontal sinus by retained mucus (*frontal mucocele*). The *treatment* is chiefly the same as in other parts. Malignant tumours should be freely removed with, if necessary, the eyeball and the contents of the orbit, and chloride of zinc paste in some cases applied on strips of lint for a few days afterwards.

ENUCLEATION OF THE EYE.—Patient lying down and as a rule under general anæsthesia; operator standing behind the head; spring speculum in lids. Seizing the conjunctiva with a pair of fixation forceps at outer or inner border of cornea, divide the conjunctiva and subconjunctival tissue all round the cornea with scissors; raise each rectus tendon in succession on a squint hook (Fig. 246) and divide each one close to the globe; now separate the limbs of the speculum and the eyeball will project forwards; pass a pair of stout curved scissors, closed, behind the globe from the outer side, and feel for the optic nerve; then pull back the scissors slightly, open them, and divide the nerve. The globe, now pushed forwards by the scissors, is taken between the fingers and thumb, and the other attachments are divided by the scissors. After the operation, firm pressure is applied by a bandage. There is but rarely any trouble from hæmorrhage. An artificial eye may be given about three months after operation, if the socket is healthy.

IX. *Errors of refraction and accommodation.*

The light percipient portion of the eye exists at the external layer of the retina (*rods and cones*), and it is necessary for perfect vision that images of external objects should be accurately focussed on this layer. Rays of light passing into the eye are refracted at the anterior surfaces of the cornea, lens and vitreous, and brought to a focus at a point varying with the refraction. The human eye for the sake of simplicity may be considered as represented by a convex lens of 23 mm. focus; and the following laws regulating the passage of light through a convex lens will then be applicable to it. Rays of light passing through a convex lens (Fig. 245, L) parallel (P) to the principal axis (X X), and therefore coming from infinity, are brought to a focus at a point (Em.) (*principal focus*) varying inversely in distance to the convexity of the lens; rays coming from a point (D) closer than infinity (*divergent rays*) are refracted further back (My.) from the lens than the focal point; and rays coming from a point (C) beyond infinity (*convergent*) are focussed at H between the lens and its principal focus Em.

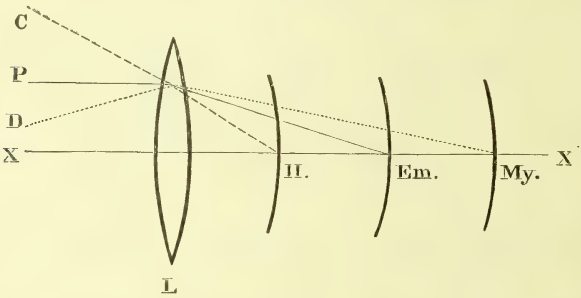


Fig. 245.—Diagram to illustrate errors of refraction. L. Convex lens. X X. Principal axis. D. Divergent ray. P. Parallel ray. C. Convergent ray. H. Em. and My. Position of retina in hypermetropic, emmetropic, and myopic eyes.

EMMETROPIA.—In an eye of normal refraction (*emmetropia*) with its accommodation relaxed, parallel rays (P) passing through the pupil will be focussed by the surfaces at a point (Em.) represented by the external surfaces of the rod and cone layer of the retina; divergent rays (D) will be focussed behind the retina at My.; and convergent rays (C) in front of the retina at H. In order to focus the divergent rays (D) upon the retina (Em.) it is necessary to increase the convexity of the lens and so shorten its focal length. This is done by accommodation, and a young emmetrope with normal accommodation should be able to focus on his retina all rays from parallel to divergent ones starting from a few inches from his cornea.

HYPERMETROPIA is the condition in which in the eye at rest the retina (H) only receives convergent rays (C); parallel rays (P) and divergent rays (D) are refracted beyond the retina (H). This takes place from too short a distance between the cornea and the retina, or from lessened convexity of the lens; the usual cause is congenital shortness of the axis of the eye. Hypermetropes from this fact are obliged to accommodate for parallel rays, and still more for divergent ones. The *treatment* naturally is to increase the convexity of the lens artificially by giving a convex lens; and by so doing allowing parallel rays to be refracted on the retina, and then the ciliary muscle will be able to focus divergent rays on the retina. In children and young adults, to find out their hypermetropia it is often necessary to order atropine before testing the refraction. The *symptoms* of hypermetropia are pain and discomfort on reading, congested eyelids and conjunctivæ, spasm and fibrillar twitchings of the lids, convergent strabismus, and headache. Hypermetropia is usually congenital, often hereditary, and is frequently associated with a flat-looking face, shallow orbits and small eyes.

MYOPIA is the opposite condition to hypermetropia, and in it the retina (My.) only receives certain divergent rays (D). It is due as a rule to the axis of the eye being too long, or in some cases to the ciliary muscle rendering the lens too convex (*spasm of accommodation*). The *treatment*, except in cases of spasm of accommodation, is to give concave glasses to allow parallel and divergent rays to fall on the retina. In low degrees of myopia it is only necessary to order glasses for distance, but in high degrees it is usual to order a stronger pair for distance, and a weaker pair for reading. In apparent myopia due to spasm of the ciliary muscle it is important to order atropine to find out the true refraction. Myopes often have the head elongated in the antero-posterior diameter, a long face and large prominent eyes. Myopia is generally accompanied by a crescent at the outer side of the disk (*posterior staphyloma*), and there may be secondary choroidal trouble, detachments of the retina, and vitreous opacities.

ASTIGMATISM is the condition in which one or more of the refractive surfaces have not the same curvature in all directions. Astigmatism may be divided into—(1) *irregular*, in which there is a difference of refraction in the different parts of the same meridian due to changes in the lens and cornea; and (2) *regular*, where there is a difference in two meridians (*chief meridians*) at right angles to one another, and called those of maximum and minimum refraction. It is usually corneal (*static astigmatism*), but may be due to the ciliary muscle (*dynamic astigmatism*). Regular astigmatism may be—(*a*) *simple*, where one meridian is emmetropic and the other hypermetropic or myopic, and is then called simple hypermetropic or simple myopic astigmatism; (*b*) *compound*, where the chief meridians are unequally myopic (compound myopic astigmatism) or unequally hypermetropic (compound hypermetropic astigmatism); or (*c*) *mixed*, where one chief meridian is hypermetropic and the other myopic. Persistent headache is commonly met with in astigmatism. The *treatment* is by cylindrical glasses for simple astigmatism, and by cylindrical glasses in combination with sphericals for compound and mixed.

PRESBYOPIA.—In the eyes of all persons from 40 to 45 years of age it is found that, owing to changes in the elasticity of the lens, the ciliary muscle begins perceptibly to lose its power of altering the convexity of the lens. The effect of this will be to prevent near objects being focussed on the retina at the usual reading distance; in order to counteract this condition and to help the ciliary muscle it is necessary to prescribe convex glasses for reading. It has been found that the glass needed is about one dioptre for every five years after 40.

X. *Strabismus and ocular paralysis.*

STRABISMUS (*squint*) is always present when the two eyes are not directed simultaneously towards the same object, and is usually accompanied at some time by double vision (*diplopia*). Strabismus occurs from over-action, weakness, or paralysis of one or more of the extrinsic ocular muscles. It is usually convergent or divergent, but may be upward or downward. It may be constant or occasional (*periodic*), and though usually only one eye squints, yet sometimes both eyes may do so in turn (*alternating*). When the squinting eye follows its fellow normally in all its movements the squint is called *concomitant* in contra-distinction to *paralytic*. Diplopia is much more marked in paralytic than in concomitant squint. The non-squinting eye is called the *fixing* eye, and strabismus may be estimated by telling the patient to look at an object about two feet away with the fixing eye, and then taking the distance between the middle of the palpebral aperture and the middle of the cornea of the squinting eye (*primary squint*); on now making the squinting become the fixing eye the amount of deviation of the original fixing eye is taken (*secondary squint*). In *paralytic* cases the secondary squint exceeds the primary, but it is equal to or less than the primary in *concomitant* squint.

Convergent strabismus (*internal squint*) is most commonly due to hypermetropia, owing to the fact that the excessive accommodation necessitates a correspondingly great convergence; but it may occur occasionally in myopia, and follows division or paralysis of an external rectus.

Divergent strabismus (*external squint*) is caused from insufficiency of convergence power, and weakness of the internal recti, especially in myopia; from defective vision of an eye, as in corneal nebulæ; and from division or paralysis of an internal rectus.

The *treatment* of concomitant strabismus is by atropine, eserine, spectacles, prisms, and stereoscopic exercises. The operations that may be required are either tenotomy of the muscle of the affected side, or advancement of the muscle of the opposite side. As a rule only one eye should be operated on at a time. The treatment of paralytic strabismus is by constitutional remedies and galvanism of the affected muscle.

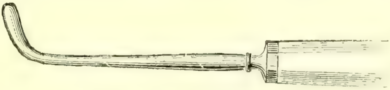


FIG. 246.—Strabismus hook.

Tenotomy of the internal rectus.—Patient lying down and under cocaine or general anæsthesia; operator standing in front and to the right hand side. Introduce the spring speculum, and pinch up with a pair of fixation-forceps the conjunctiva and subconjunctival tissue at the point of junction of the lower horizontal and inner vertical tangents to the cornea. Divide this fold with a pair of blunt-pointed scissors, making the incision only large enough to admit the points of the scissors, and then, passing the scissors through the incision, divide the capsule of Tenon. Pass the strabismus hook (Fig. 246) into the wound, directing its point backwards, and then turn the end of the hook upwards between the globe and the tendon, until its point is seen beneath the conjunctiva, at the upper border of the tendon. Introduce the scissors through the wound, and open the blades on either side of the tendon between the globe and the hook, and by one or two snips cut through the tendon. Remove the hook and then reintroduce it to see if the tendon is completely divided. The eyes should be bandaged for about twelve hours. The method is the same for the external rectus, but it must be remembered that the tendon is situated a little further back.

OCULAR PARALYSES.—*Complete Paralysis of the Third Nerve* is characterized by complete ptosis; external strabismus; inability to move the eye completely up, down or in; crossed diplopia; moderate mydriasis and inactivity of the pupil to all the reflexes; and paralysis of accommodation. Any one of the muscles supplied by the third nerve may be separately paralysed, also the superior oblique (fourth nerve) and the external rectus (sixth nerve). *Paralysis of the external rectus* gives rise to internal strabismus, inability to move the eye outwards, and homonymous diplopia. It is the most common of the ocular palsies, probably from the long course of the sixth nerve. All the external ocular muscles may be paralysed at the same time (*ophthalmoplegia externa*).

The intra-ocular muscles are the pupillary (*sphincter pupillæ*) and the ciliary. The *pupillary* muscle may be affected by paralysis of the third or short ciliary nerves, producing medium mydriasis, and by paralysis of the cervical sympathetic or long ciliary nerves, producing partial miosis. The ciliary muscle may be paralysed (*cycloplegia*) by affections of the third or short ciliary nerves, usually in conjunction with paralysis of the pupillary muscle. It may be paralysed alone as in diphtheria. In certain diseases, especially locomotor ataxia, the pupil acts to accommodation but not to light (*Argyll-Robertson or spinal pupil*).

The *treatment* of ocular paralyses is chiefly constitutional. Many are of syphilitic origin and require mercury or iodide of potassium, but faradisation of the affected muscle may also be employed. In mydriasis and cycloplegia, the use of eserine is indicated.

NYSTAGMUS (*involuntary oscillations of the eyeball*) is generally binocular, and the movements of the eyes are usually horizontal or rotatory. It occurs generally in early life and is then due to defect of sight from corneal ulcer, &c.; sometimes in adult life in patients with diseases of the nervous system such as disseminated sclerosis, and in coal miners, in whom it is probably due to their position at work.

DISEASES OF THE LIPS, CHEEKS, AND MOUTH.

HERPES OF THE LIP.—A crop of herpetic vesicles which burst in a few days leaving small scabs, are common on the lip during slight attacks of catarrh, indigestion, &c. Their occurrence in pneumonia is well known.

CRACKS AND FISSURES OF THE LIP following exposure to cold, &c., in dyspeptics, are very common, and, if neglected, may form deep and painful fissures, prone to bleed and obstinate to heal. They may leave a permanent and disfiguring scar. A simple ointment, and if persistent, touching them with solid nitrate of silver, will generally suffice to cure them. Should the margins become indurated and resist the above treatment, the scar may be excised by a V-shaped incision and the wound united by horsehair sutures.

They must not be mistaken for the fissures about the corners of the mouth so common in congenital and acquired syphilis.

PAPILLOMATA OR WARTY GROWTHS OF THE LIP are of interest in that they are liable as age advances to become epitheliomatous. They may sometimes grow out in the form of horns. Extirpation with the knife is the proper treatment.

SUPERFICIAL ULCERS on the inner surface of the lip are common accompaniments of errors in digestion, and of secondary syphilis. There are usually similar ulcers on the side of the tongue and cheeks. Nitrate of silver or chromic acid lotions (gr. x. to ℥j.) are the best local applications.

NÆVUS OF THE LIP when small may be touched with nitric acid or ethylate of sodium; and when pendulous and projecting from the free margin, ligatured. When involving the whole substance of the lip it may be treated by electrolysis, or, better, excised by means of a V-shaped incision.

HYPERTROPHY OF THE LIP, generally the upper, is often met with in connection with cracks and fissures in strumous children, and is known as the *strumous lip*. A similar condition is sometimes met with in congenital syphilis and in chronic nasal catarrh. The thickening, as a rule, disappears under constitutional treatment, and as the patient grows older. The removal of a wedge-shaped piece, as advised by some, can seldom be necessary.

CHANCRE OF THE LIP is most frequently met with in young adult life and in women; it sometimes occurs in infants. It is due to direct inoculation by mucous tubercles on the lips of another person, or may be conveyed by cups, spoons, pipes, towels, &c. It occurs as a painless, circumscribed, somewhat indurated patch or ulcer, with smooth surface and regular outline, and is attended with enlargement and induration of the submaxillary glands, and later with skin eruptions and other signs of secondary syphilis. The local lesion speedily disappears under a mercurial course.

CARBUNCLE OF THE LIP is a most dangerous disease, as it is very likely to lead to infective phlebitis of the facial vein, which may spread thence through the ophthalmic vein to the cavernous and other cranial sinuses, and terminate in infective meningitis or in general blood-poisoning. It may be distinguished from malignant pustule, which it may somewhat resemble, by the absence of the anthrax bacillus. Free incisions should be made, the sloughs scraped away, antiseptics applied, and the strength supported by fluid nourishment and stimulants.

ADENOMATA, OR LABIAL GLANDULAR TUMOURS (Paget), occasionally occur in the lip as small, smooth, elastic growths projecting under the mucous membrane. They sometimes contain nodules of cartilage, and are then of harder consistency. They should be removed from the mucous surface to avoid scarring.

Cysts due to obstruction of the mucous follicles are frequent in the lip. They contain a glairy fluid, and appear as small, tense, semi-translucent, globular, bluish-pink swellings on the mucous surface. A free incision through the mucous membrane, and removal of the cyst-wall with forceps, is perhaps the best treatment.

Epithelioma (*squamous carcinoma*) nearly always occurs in men, and on the lower lip; and although it may affect non-smokers, it generally appears to be due to the irritation and heat of a short clay pipe. It begins as a crack, small ulcer, or indurated tubercle, and may either spread superficially along the free margin of the lip, or extend deeply into its substance. Sooner or later it involves the whole lip and adjoining parts, becomes adherent to the jaw, and invades the bone. The lymphatic glands in the neck become involved and may attain a large size, even whilst the primary growth in the lip is quite insignificant; dissemination through internal organs is rare. If removed early an epithelioma of the lip may not recur till after a long period of immunity, or perhaps not at all. It seldom returns in the scar, but in the lymphatic glands, the patient dying of exhaustion induced by ulcerating and bleeding masses in the neck. The affection is very apt to be mistaken for *hard chancre*, and the latter has ere now been cut away under the impression that it was an epithelioma. The following points should serve to distinguish them:—1. Epithelioma generally occurs in the old, and in men, and on the lower lip; chancre in the young, in women, and on the upper lip. 2. The epitheliomatous ulcer has hard, sinuous, and everted edges, and an indurated and warty base; the chancrous is raised, excoriated, smoother, and the induration is more circumscribed. 3. In the malignant affection, the glands, as a rule, are not affected till late in the disease—perhaps six months; in the syphilitic early, say six weeks. Moreover, in chancre secondary symptoms will be present or soon appear, and the disease readily yields to antisyphilitic remedies. *Treatment.*—Free and early excision is imperative. The growth may be either included in a V-shaped incision, the wound being afterwards united by hare-lip pins, or if superficial, freely shaved off. The glands in the neck, if enlarged and not too extensively diseased, should be extirpated at the same time. When the bone is involved, a portion of the jaw may be removed if the whole disease can be got away.

Hare-lip is a congenital malformation in which the upper lip is vertically cleft on one or both sides of the median line. It is so named from its fancied resemblance to the lip of the hare. It is said by Kölliker to be produced by the failure of union of the fronto-nasal process which forms the median portion of the lip with the maxillary processes, which, he holds, form the lateral portions. According to this view the fissure will be opposite the suture between the superior maxillary and inter-maxillary bones; *i.e.*, between the lateral incisor and canine tooth (Fig. 257). Albrecht, however, maintains that the lateral nasal process enters into the formation of the lip and that the intermaxillary bone is developed in part from the frontal and in part from the lateral nasal process. On his view the cleft is opposite the suture between these two parts, *i.e.*, between the central and lateral incisors (Fig. 257). The hare-lip will be single or double, according as the failure of union occurs on one or both sides. It may exist as a mere notch on the free margin of the lip, but it more frequently extends deeply through the substance of the lip into the nostril above. In very rare instances it may reach the inner canthus of the eye in the form of an open cleft, due to the non-closure of the fissure existing between the fronto-nasal process, from which are developed the nasal septum, the external nose, the intermaxillary bone and the philtrum, and the maxillary process which form the upper jaw and cheek. Single hare-lip is far more common than double hare-lip, and occurs much more often on the left than on the right side. The two margins of the cleft are often unequal in length, the lip on one side of the cleft being on a lower level than on the other. In double hare-lip the central portion is generally shorter than natural, and, along with the intermaxillary bone and the incisor teeth, frequently projects forwards, the two clefts being often of unequal extent. Cleft palate is a frequent concomitant of hare-lip, and malformations, such as club-foot, spina bifida, &c., are not uncommon in other parts of the body at the same time.

Treatment.—The edges of the cleft should be pared, and the raw surfaces brought into contact, and there held by hare-lip pins or 3 – sutures, so that primary union may occur. The operation is best done between the third and fifth months of infancy, as very young infants bear hæmorrhage badly, and later, the troubles of teething begin. To ensure success the child should be brought into the best possible state of health by careful nursing and feeding, and any constitutional taint, as syphilis, corrected by appropriate remedies.

There are various methods of operating. Here only the more simple can be described. Whatever method is adopted, the objects to be kept in view are—1, to obtain primary union throughout the vound, and hence the minimum of scarring; 2, to ensure the nargin of the prolabium and free border of the lip respectively being in line; 3, to prevent the formation after the operation of a notch at the line of union. These objects are best attained by well reeing the lip from the gums at the apex of the cleft so as to avoid ension; by using a sharp knife so as to ensure clean incisions; by aking care to completely pare the margins of the cleft, and to emove sufficient tissue to secure broad, raw surfaces; by passing he hare-lip pins on the same level, and deeply enough to bring the whole of the raw surfaces into contact; and by making the cuts in paring the edges concave towards the middle line of the cleft, so as to lengthen the line of union and allow for retraction.

Operation for single hare-lip.—Having placed a Smith's clamp (Fig. 247) on the lip on either side of the cleft to control hæmorrhage, pare the edges of the cleft with a sharp narrow-bladed scalpel, taking care to remove the whole of the rounded portion of the prolabium on each side of the base of the cleft; and having freed the lip from the gums at the apex of the cleft, bring the raw surfaces together by hare-lip pins, passing the lower one first to ensure the free edge of the lip and prolabium being in line. The lower pin should be entered a quarter of an inch from the margin of the cleft, and made to transfix the coronary artery; but it should not penetrate the mucous membrane, as, if this be done, the mucous membrane will double in and prevent union. A second pin will generally be necessary, and should be passed in the same way, and a silk suture twisted round each. The sharp ends of the pins should be nipped off with pliers, a small piece of oiled lint placed beneath them to prevent injury to the cheek, and several sutures of horsehair passed superficially to keep the edges of the wound in accurate apposition. The parts should then be dried, and covered with iodoformized collodion, and a dumb-bell-shaped piece of strapping applied across from cheek to cheek to prevent traction.

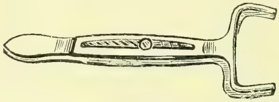
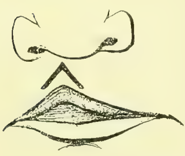
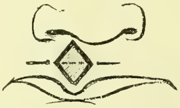
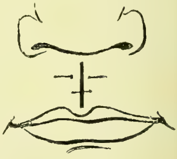


FIG. 247.—Smith's clamp for controlling hæmorrhage during operation for hare-lip.

FIG. 248. FIG. 249. FIG. 250.







FIGS. 248, 249, 250.—Operation for single hare-lip when the fissure does not extend into the nostril.

The pins should be removed at the end of twenty-four to thirty-six hours, as otherwise they will leave scars. The twisted suture should be left on till firm union has occurred, and the strapping reapplied. Where the fissure does not extend through the whole lip, an inverted V-shaped incision may be made, with its angle just above the apex of the cleft (Fig. 248), each arm stopping short of the prolabium; the tissues included in the arms of the V should now be drawn down, and a diamond-shaped wound thus formed (Fig. 249). On bringing the raw surfaces together, a projection in place of the fissure will exist on the free border of the lip

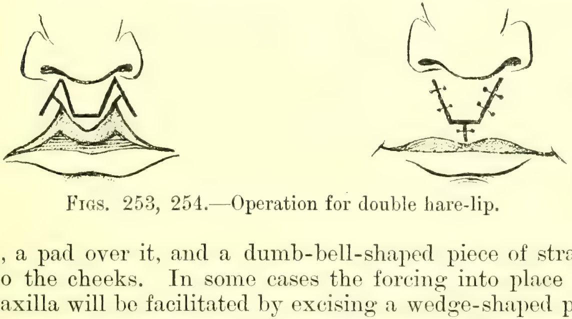
(Fig. 250); but this will disappear in time, leaving the lip nearly natural. When there is much irregularity between the two portions of the lip (Fig. 251), the incision on the shallower side should stop short of the prolabium, so as to allow the flap thus formed to remain attached at its base. On the deeper side the incision should slope off at an angle through the prolabium, completely removing the tissue. The flap left on the shallower side should be now turned down and united to the sloped-off portion on the deeper side, and the vertical portions of the incision brought together as usual. Thus, what was the free edge of the cleft on the shallower side, now becomes the free edge of the lip (Fig. 252).

FIG. 251. FIG. 252.

FIGS. 251, 252.—Operation for single hare-lip when the sides of the fissure are unequal.

Operation for double hare-lip.—When the intermaxillary process projects, it should not, as a rule, be removed, but previous to the operation for uniting the lip be partially detached with the cutting pliers, having one blade blunted by being wrapped in lint, and then be forced back into place and there secured by a plug of gauze in the wound, a pad over it, and a dumb-bell-shaped piece of strapping fixed to the cheeks. In some cases the forcing into place of the intermaxilla will be facilitated by excising a wedge-shaped portion of the nasal septum to which this bone is attached. There are many ways of uniting the lip. The simplest, perhaps (Figs. 253 and 254), consists in paring completely the central portion, and then making two flaps from the lateral portions, bringing them down and uniting them to each other below the central portion, and also

FIG. 253. FIG. 254.



FIGS. 253, 254.—Operation for double hare-lip.

to it, so that they may fill up the gap left by the deficient length of the central portion.

Rodent ulcer most often occurs on the face, especially near the inner canthus of the eyelids and the side of the nose, and is therefore conveniently described here. It is also met with on the scalp, the forehead, and the ear, and more rarely on the neck and chin, and even on the limbs and breast, and indeed wherever there are hairs and sebaceous follicles. Rodent ulcer is now regarded as a form of carcinoma; it differs from ordinary carcinoma, however, in that it is much slower in its growth, and does not become disseminated, affect the lymphatics, nor return after complete removal. *Pathology.*—In the early stages the disease is not an ulcer but a new growth, and in exceptional cases the new growth preponderates over the ulceration, so that a mass of some size is formed. Rodent ulcer, unlike squamous-celled epithelioma, does not grow from the surface, but begins in the subcutaneous tissue, and it is only after it has spread some little distance superficially that the epidermis ulcerates. The new growth is believed to originate from the external root-sheath of the hair follicles, or more probably from the sebaceous glands. *Microscopically* the earliest manifestation is the appearance under the epidermis of irregular groups of small round or oval cells lying in a fibrous matrix (Fig. 255). These cells may sometimes be seen continuous with

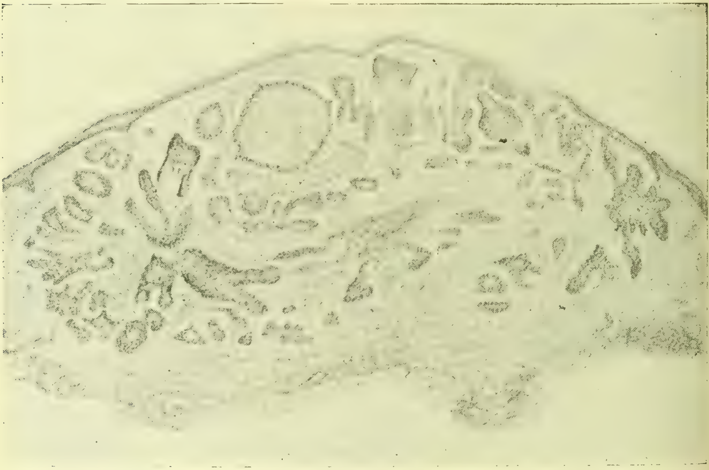


Fig. 255.—Early stage of rodent ulcer before it has pierced the epidermis. (From a drawing by Professor Kanthack.)

the cells of the sebaceous follicles and external root-sheath. Here and there irregular and ill-formed cell-nests occur, which, however, are not horny or keratinoid. The ulceration is preceded, indeed is caused, by the extension of the new growth. From squamous-celled epithelioma rodent ulcer differs in that in the latter the cells are smaller and rounder, cell-nests are either absent or are ill-formed and never horny, and the processes of the growth spread superficially instead of deeply, and are flask-shaped and much branched. *Signs.*—The disease is one of advanced life, and seldom occurs before fifty. It is twice as common in men as in women. It generally begins as a small tubercle, which later becomes an ulcer. The ulcer is generally single; its edges are irregular, sinuous, and a little raised, and but very slightly if at all indurated; its base is slightly depressed, glazed, void of granulations, generally of a pale pink colour, and at times covered with a scab. The skin around is healthy. Although attempts at cicatrization are sometimes seen, the cicatrix readily breaks down, and the ulcer, which never quite heals, slowly extends, destroying muscle, cartilage, and bone, till at the end, perhaps, of twenty or thirty years it has destroyed a great part of the bones of the face, one or both of the eyes, and the cartilages and bones of the nose, leaving a horrible and unsightly chasm. *Treatment.*—The growth or ulcer should be freely excised. If done early the prognosis is good, as it is only when some of the growth is left that a recurrence need be feared. Even in the later stages, when much tissue has been destroyed, free removal with the knife and the application of caustics to what cannot be thus removed, will sometimes stop the further progress of the growth.

STOMATITIS, or inflammation of the mouth, may be divided into the aphthous, the parasitic, the ulcerative, the syphilitic, the mercurial, and the gangrenous.

Aphthous stomatitis generally depends upon some digestive disturbance, and is common in young children. It is characterized by white patches of erosion on the mucous membrane of the lips, cheek, and tongue. Rhubarb and magnesia, and locally borax and honey, are the usual remedies.

Parasitic stomatitis, or thrush, resembles the preceding, but depends upon the presence of a parasite known as the *oidium albicans.* It is generally merely symptomatic of other diseases, to the alleviation and cure of which the treatment should be directed.

Ulcerative stomatitis is more serious, but is still, as a rule, superficial. It may depend upon digestive disturbance, local irritation of cutting teeth, or bad hygiene. The ulcers are covered with a grey slough, the gums are red and swollen, and the breath is foul. A stimulating plan of treatment is generally required, with attention to the digestive functions, hygienic surroundings, &c. Locally, the mouth should be rinsed out with a wash of chlorate of potash.

Syphilitic stomatitis is common during the secondary and tertiary stages of syphilis, and requires no further mention.

Mercurial stomatitis, depending upon an overdose of mercury, or some idiosyncrasy of the patient to the drug, is of less frequent occurrence in its severe forms than formerly. It is attended with foul breath, swollen tongue, spongy gums, profuse salivation, swelling of the parotid and submaxillary glands, and loosening of the teeth. It may terminate in gangrenous ulceration, with extensive destruction of the soft tissues, and perhaps necrosis of the bones. Chlorate of potash, both internally and as a mouth-wash, should be given; and the strength supported by fluid nourishment and, if indicated, by stimulants.

Gangrenous stomatitis, or *cancrum oris*, is a phagedænic ulceration, which begins on the inside of the cheek, and if not checked rapidly involves its whole thickness. It is very apt to terminate in blood-poisoning. It appears to depend upon thrombosis of the capillaries, a condition probably induced by the presence of a specific, but as yet unknown, micro-organism. Gangrenous stomatitis is most frequently met with in under-fed, debilitated children recovering from one of the exanthemata, typhoid fever, &c., or subjected to bad hygienic conditions. A foul and black slough preceded by great tenderness and fœtid breath forms in the mouth, and a dusky patch soon appears on the surface of the cheek, which becomes hard and brawny, and then black. The ulceration may extend to the gums, and if the disease is not soon arrested, extensive sloughing occurs, toxæmic symptoms set in, and the patient dies comatose, of general blood-poisoning, or of bronchitis or pneumonia; or he may recover, but with the loss of a large part of the cheek, leaving the mouth and pharynx exposed. It appears to be of a nature similar to the gangrenous inflammation of the female genitals known as noma. The *treatment* must be energetic. The parts should be well dried, and thoroughly destroyed with fuming nitric acid; or boroglyceride may be applied in milder cases. If the gangrenous process is not arrested all the infected tissue should be cut away, portions of the jaw being gouged out if necessary. Free bleeding will show that healthy tissues have probably been reached; but as a further precaution the raw tissues may be mopped over with fuming nitric acid. The chasm thus left may subsequently be closed by a plastic operation. The strength in the meanwhile must be supported with strong beef-tea, brandy-and-egg mixture and nutrient enemata. Recumbency should be insisted upon during convalescence, since there is a tendency to fatal syncope, which may remain for some time.

SALIVARY CALCULI are sometimes met with, blocking the orifice of Wharton's duct, or, more rarely, one of the ducts of the other salivary glands. They are composed of animal matter, impregnated with phosphate and a trace of carbonate of lime. Generally they can be seen, or at any rate felt, in the interior of the mouth, as hard bodies in the course of the duct. They may give rise, by causing retention of the secretion of the gland, to swelling, pain, and tenderness in the obstructed gland, and sometimes to suppuration and salivary fistula. An incision through the mucous membrane over the calculus will allow of its removal with a scoop or forceps. Should stricture of the duct follow, it must be divided transversely.

RANULA is a bluish-white, semi-translucent, globular or ovoid swelling situated in the floor of the mouth beneath the tongue, and containing a glairy mucoid fluid. Mr. Morrant Baker has conclusively shown, by introducing a small bristle into the duct by the side of the swelling, that it is not usually a dilatation of Wharton's duct, as was formerly taught. It has been variously attributed to—1. An enlargement of one of the mucous follicles under the tongue (*mucous cyst*). 2. A dilated acinus of one of the salivary glands (*salivary cyst*). 3. An enlargement of a bursa mucosa (*bursal cyst*). 4. An enlargement of the glands of Blandin or Nuhn (*retention cyst*), which are situated under the tongue near the tip. It is painless, but interferes, to a greater or less extent according to its size, with the movements of the tongue in speech and deglutition. Sometimes these cysts attain a large size and extend deeply in the neck, presenting below the jaw. *Treatment.*—After painting the parts with a twenty per cent. solution of cocaine, a portion of the cyst-wall should be pinched up with nibbed forceps, and a good-sized piece of it excised with curved scissors. A deep hold must be taken or the mucous membrane, which adheres but loosely to the cyst, will alone be caught up. The fluid should be squeezed out, and the lining membrane cauterized with a stick of nitrate of silver, and the opening kept free by the daily passage of a probe, so that healing may take place from the bottom. If a mere incision is made, the cyst is nearly sure to fill again. A seton will sometimes answer, but it is not always reliable; if, therefore, the treatment above indicated fails, the cyst should be dissected out.

mucous cyst
salivary
bursal
retention

BURSAL AND DERMOID CYSTS.—*Pathology.*—These cysts, which contain a glairy fluid or a grumous, sebaceous material, project both under the tongue and in the neck below the jaw. Those in the middle line of the neck or tongue may be due to, 1, *Bursal enlargements* or, 2, *Tubulo-dermoids*, originating from obsolete ducts. 1. The *bursæ* in this region are three (*a*) one over the pomum Adami, (*b*) one between the thyroid cartilage and posterior surface of hyoid bone, and (*c*) one between the genio-hyo-glossi muscles. 2. *Tubulo-dermoids* arise in connection with the thyroglossal duct (*His's duct*). The thyroid body is developed from the buccal cavity by an evagination of buccal epithelium into the mesoblast forming the tongue. The invagination occurs at the foramen cæcum, and the tube leading from this to the thyroid body eventually atrophies. Owing to the development of the hyoid bone the duct is divided into an upper segment, the *lingual duct*, from which arise the tubulo-dermoids; and a lower segment, the *thyroid duct*, which may lead to the formation of median cervical fistulæ and accessory thyroids. The tubulo-dermoids may be situated (*a*) near the foramen cæcum, bulging under the tongue, or (*b*) in the neck, projecting perhaps as low as the pyramidal or middle lobe of the thyroid body. The cysts on one side of the neck are dermoid formations in the regions of the branchial clefts. As they increase in size, they send prolongations in various directions, and sometimes become connected with the carotid sheath. *Signs.*—The middle-line cysts form fluctuating swellings in the front of the neck, and when due to enlargement of bursæ are often translucent. In the lateral cysts fluctuation may sometimes be obtained by one finger in the mouth and another on the cyst in the neck. When they extend to the sheath of the great vessels the pulsation of the carotid may be communicated to them. *Treatment.*—The bursal cysts should be removed through a vertical incision over them in the middle line of the neck. The dermoids, when they project under the tongue and are not too large and apparently moveable, may at times be shelled out through an incision in the floor of the mouth to prevent scarring. Otherwise they must be dissected out through an incision in the neck.

DISEASES OF THE TONGUE.

TONGUE-TIE is due to the tongue being more or less tightly bound down to the floor of the mouth by the shortness of the frænum. It is apt, when well marked, to interfere with sucking, and later, with distinct speech. It is easily remedied by dividing the frænum with probe-pointed scissors, care being taken to direct the points downwards and backwards and merely to notch the free border, lest the ranine artery be wounded, an accident which, in infants, has been attended with severe, and in some cases fatal, hæmorrhage. If the division of the frænum is too free the tongue may loll backwards, pressing the epiglottis over the entrance of the larynx, and produce severe dyspnœa or even fatal asphyxia—"swallowing the tongue," as it has been called. On drawing the tongue forwards the symptoms will at once cease; but a ligature should be passed through its tip and secured to the cheek, with instructions to again draw the tongue forwards with the ligature, should the symptoms recur.

NON-DIFFERENTIATION of the tongue from the surrounding tissues gives rise to the rare malformation in which the tongue appears bound down to the floor of the mouth. This condition must not be mistaken for that called *ankyloglossia*, in which the tongue, in consequence of cicatricial adhesions, presents a similar appearance. Division of the adhesions in the latter case will do much to remedy the affection.

MACROGLOSSIA, OR HYPERTROPHY of the tongue, may be congenital or acquired. In either case it is rare. *Signs.*—The whole tongue is uniformly enlarged, and sometimes so much so that it presses forwards the alveolar process of the lower jaw with the incisor teeth, and protrudes from the mouth, hanging downwards as low as the chin. When thus exposed the mucous membrane becomes cracked, spongy, and bluish-red, and is subject to repeated attacks of subacute glossitis. *Pathology.*—The affection appears to be due to a blocking of the lymphatics at the base of the tongue; at any rate the lymphatics are found enlarged and distended with lymph, and the connective tissue is increased in amount and infiltrated with lymphoid corpuscles. It appears related, therefore, to elephantiasis—a condition sometimes found co-existing in the neck and other parts of the body. The only *treatment* of much avail is excision of part of the organ. The removal of a V-shaped piece has been attended with excellent results. It should be done before the teeth and jaw have been deformed by the pressure.

ACUTE PARENCHYMATOUS GLOSSITIS, or deep inflammation of the tongue, may be due to mercury, fever, iodism, injury, carious teeth, stings of insects, abscesses beneath the jaw; sometimes there is no apparent cause. *Signs.*—In severe cases the whole tongue is swollen, and protrudes from the mouth, interfering with speech and deglutition, and sometimes threatening suffocation. It frequently ends in abscess. It is often attended with high fever and salivation, and may be quite sudden in its onset. *Treatment.*—Should a brisk purge and the milder measures applicable to acute inflammations fail, free longitudinal incisions, which need not be deep, should be made along the dorsum of the tongue, and the swelling will usually subside in a few hours.

SUPPURATION AND ABSCESS sometimes follow an attack of acute glossitis; but the preceding inflammation may be so slight as to be overlooked. The abscess, which then forms a firm, tense, elastic swelling in the substance of the tongue, may be mistaken for a gumma or carcinoma; but the diagnosis is readily made by an exploratory puncture. A free incision is the proper *treatment*, the cavity filling up in a few days.

CHRONIC SUPERFICIAL GLOSSITIS, also known as psoriasis, ichthyosis or leucoplakia of the tongue, is a chronic inflammation of the mucous membrane, and may be induced by syphilis, excessive smoking, some forms of dyspepsia, the abuse of spirits, jagged teeth, &c. It begins as a hyperæmia of the papillary layer, and presents at this stage slightly-raised red patches better seen if the tongue be dried. This is followed by excessive growth of epithelium, the cells of which assume a horny character, and the patches which were previously red become bluish-white, and later, opaque white. Several of the patches may now coalesce, covering in severe cases the whole or greater part of the dorsum of the tongue. It is this condition to which the term *psoriasis* has been applied from its superficial resemblance to psoriasis of the skin. Still later, from excessive heaping up of the epithelium, the surface of the organ becomes cracked and nodular, simulating *ichthyosis*, a name by which it has also been called. As the pathology of the affection, however, is distinct from that of the above-named affections of the skin, it would be better to drop these terms, and to call the affection either *leucoplakia* (*white patches*) or *chronic glossitis*. After variable periods, the hypertrophied papillæ may atrophy, or ulceration may occur; or the epithelium may grow into the substance of the tongue and the disease become epitheliomatous. At times the inflammation does not give rise to an increase of epithelium, the tongue then appearing smooth, glazed, and red. The disease, except when ulceration occurs, causes little or no pain, and often gives rise to no inconvenience; but it should always be carefully watched for any sign of its becoming epitheliomatous. A similar condition of the mucous surface of the lips and cheeks is a common accompaniment, especially in smokers (*smoker's patches*). *Treatment.*—All sources of irritation, especially smoking, stimulants and condiments, should be avoided; antisyphilitic remedies given where indicated; and soothing washes of chlorate of potash or borax applied. Should any of the leucoplakial patches show signs of ulceration the whole patch should be at once excised; or should signs of epithelioma already be present, the whole or half of the tongue should be removed.

ULCERATION OF THE TONGUE may be simple, tuberculous, syphilitic, lupoid, or epitheliomatous. Aphthous ulceration, and that following mercurial salivation, have been described under stomatitis.

Simple ulceration may depend on digestive disturbance (*dyspeptic ulcer*) or on irritation, as of a sharp or carious tooth, hot pipe stem, &c. (*dental or irritable ulcer*). Both varieties are generally superficial, and unattended with the induration and infiltration characteristic of epithelioma. The *dyspeptic ulcer* usually occurs on the dorsum of the tongue near the tip. The ulceration is sometimes extensive and multiple, and is often accompanied by some superficial glossitis at other parts of the tongue. The *dental ulcer* is situated on the side of the tongue, and generally corresponds with a carious or sharp tooth. At first it may be a mere superficial red abrasion, but if neglected, it becomes a distinct ulcer, irregular in shape, and surrounded with an inflammatory area. The edges are abrupt and a little raised, but not everted; the base is depressed, sloughing, and sometimes phagedænic, but not indurated unless the ulcer has existed some time, when it may become callous. It is always unattended with infiltration. *Treatment.*—In the *dyspeptic ulcer* the diet and bowels must be carefully regulated, bismuth or soda in infusion of calumba given internally, and soothing washes or borax and honey applied locally. Caustics must be avoided. In the *dental ulcer* any offending tooth must be filed, stopped, scraped, or extracted; in short, every source of irritation removed. The ulcer will then rapidly heal, but if neglected it may become epitheliomatous. On the first appearance of infiltration, therefore, free excision is imperative.

Tuberculous ulceration of the tongue is rare, and generally occurs in young adult males, the subjects of phthisis or of general tuberculosis. It usually begins as a small pimple or nodule on the dorsum of the tongue, especially near the tip. This, after a short time, breaks down into a round, oval or irregular, painful ulcer. The edges are slightly raised, vertical, inverted, or undermined, sometimes slightly thickened, but never everted or greatly indurated. The base is uneven or nodular, and covered with coarse, pinkish-grey granulations, or with a grey or yellow shreddy slough. Sometimes several smaller ulcers appear around the one first formed, and coalesce with it. The ulceration usually progresses in spite of treatment, the patient dying of phthisis or other tuberculous affection. The absence of glandular enlargement, of induration, and of signs of syphilis, along with the presence of tubercle elsewhere, and the characters given above, should serve to distinguish it from syphilitic and epitheliomatous ulceration. *Treatment* has hitherto been of little service. The ulcer, however, may be soothed by Ferrier's snuff or cocaine; or, if the constitutional state does not forbid, it may be scraped with a Volkmann's spoon and dusted with iodoform, cauterized with nitrate of silver, or cut out. The usual constitutional treatment for tubercle should, of course, at the same time be employed.

Syphilitic ulceration may be divided for practical purposes into the superficial and deep; the former commonly occurring in the early, the latter in the later stages of syphilis. (*a*) *The superficial ulcers* affect the side of the tongue, and are frequently associated with similar ulcers on the lips, cheeks, palate, gums, and fauces. They are usually of an oval or irregular shape and have sharply cut edges, an ash-grey base, and a surrounding areola of inflammation. They readily disappear under the influence of mercury, and the local application of a lotion of nitrate of silver or chromic acid. These ulcers are sometimes associated with a heaping-up of epithelium similar to that which occurs in mucous tubercles. (*b*) *The deep ulcers* are due to the breaking down of syphilitic gummata. They generally occur in the centre of the dorsum of the tongue as deep irregular excavations, with raised, slightly concave or undermined edges, and a base covered with a yellow slough and *débris* of breaking-down tissue. They are usually surrounded with a red areola. On healing, they leave characteristic, cracked, or stellate-looking scars. Their situation at or near the middle of the tongue, the absence of induration and of glandular enlargement, the history of the previous gummatous swellings and of syphilis, and their amenability to antisyphilitic remedies, should serve to distinguish them from squamous or other forms of carcinoma. *Treatment.*—Large doses of iodide of potassium, combined with quinine if the constitution is at all broken, and the local application of a cleansing gargle, as chlorate of potash, will rapidly cause them to heal. The scars left by these ulcers sometimes, though rarely, degenerate into epithelioma. Should any induration therefore appear in them, their free removal with the knife should at once be undertaken.

Lupoid ulceration of the tongue is very rare. I have only seen one case during an experience of thirty years at St. Bartholomew's Hospital. This was under the care of my colleague, Mr. Butlin. The case occurred in a young girl with very extensive lupus about the nose, lips, and mouth. Scraping with a Volkmann's spoon was the treatment adopted.

Epitheliomatous ulceration is due to the breaking down of squamous carcinoma. It is described under ulceration instead of amongst new growths, as in consequence of the irritation from the teeth, food, and the movements of the tongue, epithelioma in this situation very rapidly ulcerates, even if it does not begin as an ulcer; hence it is from other ulcers rather than from new growths that it has to be distinguished. It is much more common in men than in women, and seldom occurs under the age of forty. Often it is due to the irritation of a carious or sharp tooth, and then begins as a dental ulcer; or it may arise in the scar left by a syphilitic ulcer, or follow upon the condition of the tongue known as chronic superficial glossitis. Occasionally it begins as a wart or pimple in patients in whom no cause for it can be assigned. It is most common on the side of the tongue opposite the molar or bicuspid teeth. The ulcer is irregular, with raised, sinuous, hard and everted edges, and an uneven, excavated, or warty base; while the tissues around are infiltrated and indurated. Its growth is generally rapid, and attended with neuralgic pain and copious salivation. If allowed to take its course it spreads backwards to the pillars of the fauces, downwards to the floor of the mouth, and inwards to the opposite half of the tongue; whilst the submaxillary lymphatic glands, and later the lymphatic glands in the neck become enlarged, and the parts about the angle of the jaw infiltrated and matted together by the disease. Secondary ulcers then form from the breaking down of the glands in the neck, and the patient dies, worn out by pain and irritation, or exhausted by hæmorrhage; but like squamous carcinoma in other parts it seldom becomes disseminated in distant organs. *Treatment.*—Early and free extirpation ought in every instance to be undertaken, but even then a recurrence in the glands of the neck is only too frequent. When the disease has attained some magnitude, the propriety of removal becomes a question, and opinions differ under what circumstances it ought to be attempted. Its removal is contra-indicated:—1, when it has extended so far backwards that the finger cannot reach healthy tissue beyond it; 2, when it is firmly and extensively adherent to the jaw; 3, when the tongue is firmly bound down to the floor of the mouth; 4, when the glands, not only below the jaw, but deep in the neck, are much enlarged, implicating the carotid and vagus; and 5, when the patient is too weak or enfeebled by age, or emaciated from the disease itself, or from disease of other organs, to stand an operation. Moderate enlargement of the glands, slight adhesion to the jaw, and some infiltration of the floor of the mouth, do not, in my opinion, forbid an operation (especially if the patient is suffering from much pain, and is otherwise in good health), provided the whole of the disease with the enlarged glands can be got away. Where the disease is regarded as beyond the reach of extirpation, the pain and salivation may often be relieved by removing, not only decayed, but sound teeth that may be irritating the growth, or by stretching or dividing the gustatory nerve. This, which however is sometimes impracticable on account of the extension of the growth, may be done by making a small incision transversely from the last molar tooth through the mucous membrane to the side of the tongue, then passing an aneurysm needle into the wound, and hooking up the nerve, which is here quite superficial. Cocaine, or morphia and glycerine, may be painted on the part, whilst the patient's remaining span of life may be rendered bearable by increasing doses of opium or morphia.

TUMOURS OF THE TONGUE.—*Papillomatous or warty growths* are not uncommon, and may be distinguished from epithelioma, into which they are liable to degenerate as age advances, by the absence of induration about their base. They should be freely removed by the knife or scissors. *Vascular tumours* or *nævi* and *lymphangiomata* are occasionally met with, and may be destroyed by the galvano-cautery, or removed by the ligature or knife. *Fibrous*, *fatty*, *myxomatous*, *adenomatous*, *sarcomatous*, and *carcinomatous tumours* other than the squamous variety, which has already been described under epitheliomatous ulceration, are too rare in the tongue to call for further remark. For *mucous tubercles* and *gummata* see Syphilis of the Tongue.

SYPHILIS OF THE TONGUE may occur as—1. Primary chancre. 2. Mucous tubercles. 3. Superficial glossitis. 4. Superficial and deep ulceration; and 5. Gummata. *Primary chancres*, which are very rare in this situation, require no description. *Mucous tubercles* consist, as elsewhere, of heapings up of epithelium over infiltrated and enlarged papillæ, and appear as flattened elevations of a greyish-white colour. They are generally present on the palate and fauces at the same time. Mercury internally, and black wash locally, cause them rapidly to disappear. *Superficial glossitis* and the *superficial* and *deep ulcerations* have already been described. *Gummata* occur as hard, globular masses in the fibrous tissue of the septum, and also in the substance of the muscles. They may be single or multiple. The mucous membrane covering them is at first natural in appearance, but, as the gumma softens, it gives way, and a deep syphilitic ulcer is produced. Iodide of potassium is the remedy.

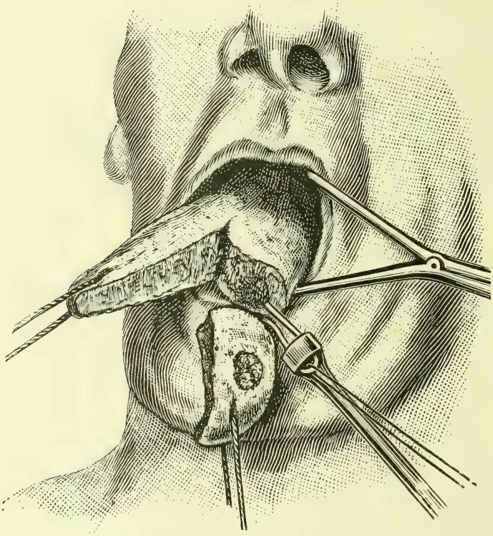


FIG. 256.—Excision of the tongue with the écraseur.

EXCISION OF THE TONGUE may be performed in many ways. Only those methods in most general use will be here described. They will be considered under the heads of, excision with (1) the knife, (2) the écraseur, (3) the scissors, (4) the galvano-cautery. The tongue is also frequently excised simultaneously with infiltrated glands through an incision in the side of the neck by (5) Kocher's method.

1. *Excision with the knife*, on account of the profuse hæmorrhage which attends it, is only applicable when the anterior portion of the tongue requires removal. The tongue should be well drawn forward and the diseased portion cut away with one sweep of the knife, and the bleeding vessels tied.

2. *The écraseur* is much less used than formerly. The mouth having been widely opened by a gag, two ligatures are passed through the tongue, one on either side of the tip, and the mucous membrane, where it is reflected from the tongue to the jaw, is divided with scissors along with some of the fibres of the genio-hyo-glossus. The mucous membrane covering the dorsum of the tongue is next divided in the middle line by a bistoury from the tip as far back as to be well beyond the disease. This allows the tongue to be readily split with the fingers into two halves. The cord of the écraseur is now passed over one half, and well behind the disease, and, if the whole tongue is to be removed, the cord of a second écraseur over the other half. The cord being tightened by screwing up the écraseur, the tongue is cut through. The lingual artery, with the gustatory nerve, is drawn out in the form of a loop by the cord of the écraseur (Fig. 256). A ligature should be passed round the artery with an aneurysm needle, and the artery severed in front of the ligature. The anterior part of the tongue will now come away, leaving the ligature on the artery in the stump of the tongue. The above is a slight modification of the operation introduced by Mr. Morrant Baker.

3. *Excision with the scissors* (Whitehead's method), consists in drawing the tongue well forward by two ligatures through its tip, dividing the frænum, splitting the tongue as described above, and then separating the diseased half from its attachments, beginning from below by a series of short snips with blunt pointed scissors, clamping or tying the lingual artery, if seen, before it is divided, or else immediately it is cut. The lingual artery lies immediately below the muscle-substance about a quarter of an inch from the middle line. If the disease involves both sides of the tongue the opposite half can next be removed in the same way. To prevent hæmorrhage during the operations, some surgeons first tie one or both lingual arteries in the neck, whilst others, for fear of blood entering the trachea, perform tracheotomy, and plug the trachea with Hahn's tampon cannula, or merely introduce an ordinary tracheotomy tube, and plug the pharynx firmly with a sponge during the operation. All such measures are, however, in my opinion, quite unnecessary, and only add to the danger of the

operation. Should bleeding occur it can always be arrested temporarily by merely passing the finger into the pharynx and pressing the tongue against the inner surface of the jaw, and then as soon as the mouth has been sponged clear of blood the bleeding vessel can be seized and tied. Some surgeons operate with the head hanging over the end of the table, so that the blood may not run down into the throat. When Hahn's cannula is used it is often kept in for several days after the operation for the purpose of excluding septic discharges from the air-passages and so preventing septic pneumonia. The advantages of the scissors over the écraseur are that a cleaner cut surface is left and consequently that the surgeon can be more certain of having removed the whole of the disease, that less sloughing occurs, and that the operation is more quickly performed. Where, however, the tongue is adherent to the floor of the mouth and hence cannot be drawn forward, or the mouth cannot be opened sufficiently wide, or the light is bad, or a reliable assistant is not at hand, removal with the scissors is attended with considerable difficulty, and under these circumstances removal with the écraseur will be found safer. As regards the amount of sloughing, I am not convinced that more attends the use of the écraseur than the scissors, and if care is taken to pass the cord of the écraseur well beyond the disease, as complete a removal can be ensured.

4. *Excision with the galvano-cautery* is strongly recommended by some surgeons, but is open to the serious objection that it is liable to be followed by secondary hæmorrhage on the separation of the sloughs.

Whatever operation is undertaken, it will be facilitated when the disease is far back by splitting the cheek from the angle of the mouth to the masseter muscle; whilst, if the disease has invaded the bone, the lower lip may be vertically divided in the middle line, the incision continued on each side for a short distance along the lower border of the ramus of the jaw, the soft parts dissected up, and the infiltrated bone removed by the saw or bone-pliers. Division of the lower jaw in the middle line and separation of the two halves is a useful procedure when the floor of the mouth is implicated and the disease extends far back. The jaw should be united at the conclusion of the operation by silver wire or by ivory pegs.

5. *Kocher's operation.*—This is an exceedingly useful method of excising one half of the tongue, together with the infiltrated glands, when the disease extends far back and is limited to one side of the organ. Make an incision from the mastoid process to the hyoid bone, and thence to the symphysis of the jaw. Divide the platysma; tie the facial artery; extirpate the submaxillary lymphatic glands, and especially the gland over the carotid sheath; tie the lingual

artery where it dips behind the hyo-glossus; extirpate the submaxillary salivary gland; divide the mylo-hyoid muscle; remove the sublingual gland, and cut through the mucous membrane of the floor of the mouth. The tongue will now be exposed as far as its root; split it down the middle line; draw the affected half out of the wound, and sever it from its connections well behind the disease with scissors.

During the removal of the tongue chloroform should be administered by a tube passed through the nose (Junker's method), or if tracheotomy is performed and the trachea plugged, through the cannula.

The *after-treatment* consists in dusting the stump with iodoform, or painting it with Whitehead's iodoform varnish, packing the mouth with iodoform gauze, or frequently syringing it with Condy's fluid or other antiseptic lotion. Some surgeons recommend feeding with a tube passed through the mouth or nose for the first few days, or by the rectum. The nasal tube, however, is often a source of great irritation, and feeding is better accomplished by a spoon or "feeder" passed well to the back of the mouth. It is well to leave a ligature through the stump of the tongue, so that should recurrent hæmorrhage occur, the stump may be drawn forwards and the bleeding vessel more easily secured.

DISEASES OF THE UVULA, PALATE, FAUCES AND TONSILS.

Uvulitis, or inflammation of the uvula, is a frequent accompaniment of pharyngeal catarrh. The uvula appears red, swollen, and œdematous, and often considerably elongated. If the inflammation does not yield to the remedies employed for the catarrh, scarification should be practised.

Elongation of the uvula may depend upon chronic catarrh of the pharynx, or upon conditions similar to those leading to chronic enlargement of the tonsils. The elongated uvula may come into contact with the back of the tongue or even with the mucous membrane of the larynx, and in either case is productive of a troublesome tickling cough. If astringents fail, the end of the uvula may be amputated.

Cleft palate is a congenital defect due to n arrest of development of the processes which ormally grow inwards from the superior maxillary and palate bones, and meeting each ther and the vomer in the middle line, and the ntermaxillary bone in front, form the hard and soft palate. This rrest of development may be complete, the fissure extending in the

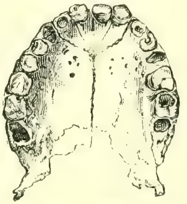


Fig. 257.—The lines of suture in the hard palate.

middle line through the uvula and the soft and hard palate, and thence through the alveolar process either on one or both sides in the line of suture of the intermaxillary with the maxillary bone, or between the two portions of the intermaxillary bone (Fig. 257). It will in this case be generally combined with double or single hare-lip respectively. When the arrest is only partial, the cleft may extend through the uvula alone, or through the soft palate as well, or through the soft palate and part of the hard; whilst in other instances the alveolar process only on one or both sides of the middle line may be notched, as occurs so often in hare-lip. The vomer, which is continuous in front with the intermaxillary bone, either presents a free border in the middle of the cleft, or is attached to one or other margins of the cleft. The *consequences* of cleft palate vary with the age of the patient and extent of the cleft. In infancy, suction and deglutition are seriously interfered with; whilst later, the voice, articulation, taste, smell, and hearing, may all be impaired.

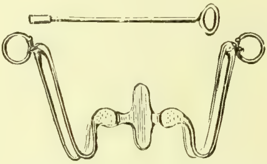


FIG. 258.—Smith's gag for cleft palate, with key.

Treatment.—The infant, if unable to take the breast in an erect or semi-recumbent posture, must be fed with the mother's milk by a spoon passed well to the back of the mouth, or by a feeding-bottle with a large teat to act as a plug to the cleft. The operation for the cure of the deformity should be undertaken before the child begins to speak, which is generally about a year later than usual. It had better not be done in infancy, as some advise, since bleeding is then badly borne, and the cleft of the bony palate diminishes in width during the first three years of life. Moreover, up to the end of the second year, the first dentition is not completed. Infants, moreover, are very liable to such ailments as catarrh of the pharynx and lungs, and coughing and sneezing tend to tear the parts asunder. The cleft in the hard and soft palate should be closed at the same time. Hare-lip, if present, should be operated on in infancy.

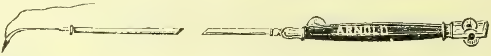


FIG. 259.—Smith's needle for passing wire sutures in cleft palate.

harelip operate 3rd – 5th mo.
[illegible] palate 〃 about end of 2nd yr

Staphylorrhaphy or closure of the soft palate. Chloroform having been given by Junker's apparatus with the tube passed through he nose, and the mouth widely opened by a Smith's gag, which depresses the tongue at the same time (Fig. 258), one end of the bifid uvula is seized with long forceps, and the edge of the cleft pared from below upwards, and the paring repeated on the opposite side. The uvula and the lower part of the palate are then united with horsehair, the upper part with silver wire. The wire sutures are best passed by Smith's needle, by which they can be carried hrough both sides of the cleft by one transit of the needle. This needle, shown in Fig. 259, has "a small reel attached behind the handle to hold the wire, and a small serrated wheel half way up the handle to protrude the wire from its tubular point." The horsehair may be passed across the cleft by the needle shown in Fig. 260, and as the point of the needle protrudes from the palate, the end of the horsehair is seized and drawn out by nibbed palate forceps or by the suture-catcher (Fig. 261), and the needle withdrawn. The silver sutures should be fastened by the wire-twister (Fig. 262) and cut off short, care being taken to hold the edges of the cleft merely in apposition and not to apply any tension. The horsehair should be tied with a treble surgeon's knot. When the parts have been brought together any undue tension should be relieved by making lateral incisions through each side of the soft palate parallel to the cleft and just internal to the hamular process with a tenotome on a long handle. By these incisions the levator palati muscles are divided. The palato-pharyngei may also be divided if necessary by notching the posterior pillars of the fauces with scissors.

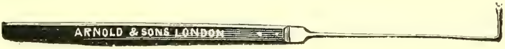


Fig. 260.—Smith's palate needle for passing horsehair sutures in cleft palate.

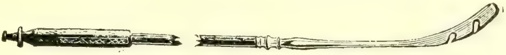


Fig. 261.—Suture-catcher.

Fig. 262.—Wire-twister.

Uranoplasty, or closure of the hard palate. The soft palate having been previously brought together in the way described, the operation on the hard may be begun at that stage where the tension becomes such that the soft parts can no longer be brought together. An incision from a quarter to three-quarters of an inch long should be made on either side of, and parallel to, the cleft through the muco-periosteum down to the bone (Fig. 263, E, E). The incisions should fall a little distance from the alveolar process, so as to avoid wounding the anterior palatine artery. Into one of these incisions a raspatory or an aneurysm needle with a short curve should be introduced, and the muco-periosteum separated from the bone along the whole length of the cleft in the hard palate, avoiding the neighbourhood of the posterior palatine foramen through which the anterior palatine artery runs. The attachment of the muco-periosteum to the posterior margin of the hard palate should be divided with curved scissors passed through the cleft and behind the soft palate, which should be drawn forwards to facilitate this step of the operation. Pressure should be made upon the parts with a small sponge by an assistant, whilst the muco-periosteum is being separated in like manner on the opposite side. The edges of the cleft had better not be pared until this stage of the operation, since now no bleeding will occur. Wire sutures should next be passed in the way described for uniting the soft palate, and any tension relieved by prolonging the cuts made for the introduction of the raspatory forwards or backwards as the case may require. Hæmorrhage, though often sharp, is seldom severe, and may generally be stopped by pressure or syringing with ice-cold water, the head being turned over to one side to let the blood escape, or if it becomes serious, by plugging the posterior palatine canal with a small peg of wood.

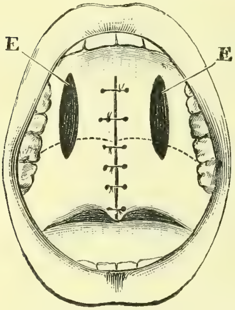


Fig. 263.—Position of the lateral incisions, E, E, through the muco-periosteum, in the operation for cleft of hard palate. The dotted line indicates the line of junction of the hard and soft palate. (Bryant's Surgery.)

After-treatment.—The patient should be fed on iced milk for the first few days, and then on soft food for a fortnight. The sutures may be left in for three weeks or a month; if the patient is unruly they should be removed under chloroform. The cleft ought to heal by the first intention, and the lateral cuts for taking off tension, by granulation. If a portion of the cleft fails to unite by the first intention it will often heal up subsequently by granulation; if not, a second operation must be undertaken. It is somewhat doubtful whether the muco-periosteum ossifies.

NECROSIS OF THE HARD PALATE is generally due to the breaking down of syphilitic gummata, and is followed by perforation and, at times, by destruction of the greater part of the hard and soft palate, and septum of the nose. *Treatment.*—Large doses of iodide of potassium, and when the ulceration has ceased, an obturator to close the perforation, and later a plastic operation if practicable.

TUMOURS OF THE PALATE.—*Innocent tumours*, the so-called *adenomata* of the palate, are not so very uncommon. They occur as smooth, rounded, prominent, firm, or elastic swellings, and readily shell out when an incision is made through the mucous membrane covering them. *Sarcomata and Carcinomata* are less frequently met with, and may be distinguished from the innocent tumours by their rapid growth, fixidity, extension towards the fauces and tonsils, by the mucous membrane being adherent and the glands at the angle of the jaw being enlarged.

ACUTE TONSILITIS may be the result of taking cold in a person in feeble health or the subject of the rheumatic diathesis, or who from previous attacks has become predisposed to the disease; sometimes it is due to septic poisoning, as from the inhalation of sewer gas; or it may occur in the course of other diseases, as scarlet fever. *Signs.*—It generally begins with a slight chill, or even a rigor, followed by high temperature, furred tongue, offensive breath, salivation, pain darting to the ear and increased on swallowing, and swelling of the glands behind the angle of the jaw. If the mouth can be sufficiently opened one or both of the tonsils are found to be red and swollen, and often in contact, blocking up the fauces. The neighbouring parts are congested and swollen, and, in the variety known as *follicular* tonsilitis, a secretion is seen oozing from the mouths of the inflamed follicles. The inflammation may now subside, or terminate in suppuration (*quinsy*), which may be known by the pain becoming of a throbbing character, and a sense of fluctuation or softening on palpation. *Treatment.*—At the onset a sharp purge should be given, whilst large doses of perchloride of iron, quinine, or salicylate of soda, with local insufflations of bicarbonate of soda, may be tried as abortives. Where suppuration threatens, the throat should be steamed, and hot camomile mattresses or boracic poultices applied externally. As soon as the abscess has formed, an incision should be made with a bistoury, guarded by wrapping it round with sticking-plaster to within half an inch from the end, and directing the point towards the middle line to avoid injuring the tonsillar arteries and the internal carotid.

CHRONIC ENLARGEMENT OF THE TONSILS consists of an hypertrophy of the normal tissue of the tonsil, and is very common in strumous children, in whom it is frequently associated with adenoid growths in the vault of the pharynx. At times it appears due to oft-repeated attacks of acute tonsilitis. The *symptoms* to which it may give rise are: a nasal tone of voice; a peculiar vacant expression, acquired by the child constantly breathing with the mouth half open; regurgitation of fluids through the nose; snoring during sleep; distressing dreams, from the imperfect aëration of the blood; and recurring attacks of acute or subacute tonsilitis; whilst deafness, from implication of the Eustachian tube and middle ear in the chronic inflammation, may sometimes be induced, and even an alteration in the shape of the chest, and possibly phthisis. The tonsils appear irregularly enlarged, often almost blocking up the fauces, but, unless inflamed, of a natural colour, or perhaps slightly paler than natural. *Treatment.*—In young children the affection may be cured by persistent painting with the tincture of perchloride of iron or tincture of iodine, combined with the internal use of cod-liver oil and syrup of the phosphate or the iodide of iron. In older children, or where the tonsils are much enlarged, they should be excised, either with the knife, or better, with the guillotine (Fig. 264) or tonsillotome, and this should be done before the voice has become seriously affected or other mischief has ensued. The hæmorrhage attending the operation, though usually slight, has at times been alarming. Gargling with cold water will generally stop it; but if this fails, ice, or astringents, as tannic acid, or pressure with a pencil guarded with lint, will nearly always succeed. Should a bleeding vessel be seen, it should be tied or twisted. In exceptional cases, the common carotid has had to be tied. Should adenoid growths be present they should be removed at the same time as the tonsils.

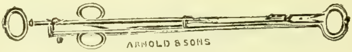


FIG. 264.—Tonsil guillotine.

ULCERATION OF THE FAUCES, PALATE, AND TONSILS may be simple, gangrenous, syphilitic, tuberculous, and malignant.

Simple ulceration, the so-called ulcerated sore throat, is generally the result of debility, induced by over-work in a close atmosphere, and hence is frequent in workers in hospital wards, where it is known as hospital sore-throat. Change of air, a nourishing diet, quinine and port wine, with a gargle of chlorate of potash, will usually relieve it. If neglected it may assume a *gangrenous* form, and extensive sloughing may then ensue, with constitutional symptoms of blood-poisoning, which often proves rapidly fatal. Stimulants and fluid nourishment should be frequently administered, and quinine, perchloride of iron, or ammonia and bark, given internally. Tracheotomy, if the larynx becomes involved, may be necessary.

Syphilitic ulceration may be superficial or deep. The *superficial* ulcers are common in the early stages of syphilis, and may be accompanied by mucous tubercles. *Deep* ulcers, due to the breaking down of gummata, occur in the latter stages as irregular excavations with sharply-cut edges and a sloughy base, but are unattended with induration. On healing they are often productive of much contraction (see *Pharyngeal Stenosis*).

The so-called *tuberculous ulceration* occurring in strumous children bears a general resemblance to the syphilitic, and is believed by some to be really the result of congenital syphilis. Like the syphilitic it may lead to extensive destruction of the parts.

Malignant ulceration is due to the breaking down of epitheliomatous and sarcomatous growths. It may be known by the sinuous, everted, and indurated edges of the ulcer and other signs of malignancy.

TUMOURS OF THE TONSIL.—*Papillomata and adenomata* are sometimes met with, the former usually as pedunculated warty growths, the latter as circumscribed, rounded, moveable tumours which readily shell out when an incision is made over them. *Sarcoma* and *epithelioma* occasionally occur in the tonsil. They grow rapidly, soon affect the lymphatic glands in the neck, and extend to surrounding parts. Unless detected and removed whilst they are quite small and localized to the tonsil they are beyond the reach of surgery. Other tumours in this region are rare.

DISEASES OF THE GUMS AND JAWS.

HYPERTROPHY of the gums has been observed as a congenital affection, and may be met with where there is overcrowding of the teeth as a lobulated fringe-like growth of the gums, which, in severe cases, may so surround the teeth that they appear as if buried in it. The hypertrophied portion should be shaved off, and one or more of the teeth extracted.

POLYPI of the gums, as they are called, are merely overgrowths of the little tongue of gum between the teeth, and appear generally o depend on the presence of tartar or caries. The offending tooth hould be scaled, stopped or extracted, and the growth cut off.

PAPILLOMATA, or warty growths, occasionally occur on the gums. hey are generally pedunculated, and can be readily snipped off with scissors.

SPONGY GUMS may occur as the result of scurvy or the abuse of ercury, and are sometimes met with in strumous children. The ondition is often associated with superficial ulceration. The *treatent* consists in the removal of the cause, the use of an astringent outh-wash, and the constitutional remedies appropriate to scurvy struma.

ALVEOLAR ABSCESS may be quite superficial (*gum-boil*) and merely require a slight prick; or it may form around the fang of a carious tooth, and then either make its way to the surface by the side of the tooth, or expand the alveolus and perforate the bone. In the latter case it may track below the reflexion of the mucous membrane from the gums to the cheek, and point about the angle of the jaw or on the cheek, and after opening leave an intractable sinus. In the upper jaw it sometimes also tracks along the hard palate, and may lead to necrosis of the bone. It is attended with severe throbbing pain, deep-seated swelling, and often great œdema of the face and eyelid. *Treatment.*—The offending tooth should be extracted, hot fomentations and bread-poultices applied inside the mouth, and the sinus divided transversely from within the mouth to prevent an external opening being formed. If a sinus exists the carious tooth or dead bone must be removed before it will heal; scraping the sinus will then facilitate the healing.

EPULIS.—This term, though formerly employed to signify any tumour growing upon the gums, is now usually restricted to the variety that was then distinguished as the fibrous or common epulis. An epulis consists principally of fibrous tissue, but may sometimes contain a few myeloid cells. It frequently appears to depend upon the irritation of a carious stump, and springs from periodontal membrane lining an alveolus. Beginning as a swelling of the little tongue-like process of gum between the teeth, as it increases in size it appears as a hard, fleshy, circumscribed, smooth or slightly lobulated, elastic growth, covered by mucous membrane. When it has existed some time ulceration of the surface may occur, and one or more teeth become loosened or fall out. *Treatment.*—It should be excised with bone-forceps or a small saw, care being taken to cut away a small piece of the bone beneath, as otherwise it is apt to return. When quite small it may be shaved off, a thin layer of the bone at its base gouged away, and the offending tooth or teeth removed.

MYELOID SARCOMA (*myeloid epulis*) is occasionally met with on the gums as a rapidly-growing vascular tumour of a purplish-red colour and soft spongy consistency. It should be very freely removed with the underlying bone, as otherwise it will return. The hæmorrhage during removal is generally free, and may require the actual cautery to restrain it.

EPITHELIOMA (*malignant epulis*) of the gums is rare. In the upper jaw it has a marked tendency to creep up into the antrum (*creeping epithelioma*) and to simulate caries or necrosis of the jaw. Free excision, with removal of the upper jaw if the antrum is involved, should be undertaken if there is a fair chance of getting the whole of the disease away and the glands are not much involved.

INFLAMMATION AND ABSCESS OF THE ANTRUM is generally due to the irritation of the fang of a carious tooth. It is attended with deep-seated pain, followed by swelling, œdema, heat, and redness of the cheek and lower eyelid, and when very acute, by sharp constitutional disturbance. The pus may overflow into the nose, or escape by the side of a tooth; or, in other instances, may distend the cavity and cause the bony walls to bulge. This condition must be distinguished from chronic empyema of the antrum. (See Diseases of the Accessory Nasal Sinuses.) The *treatment* consists in providing a free exit for the pus as soon as formed, either by removing the carious tooth and perforating the antrum through the bottom of the alveolus, or, if the teeth are sound, by perforating the anterior wall within the mouth through the canine fossa. The cavity should then be kept cleansed by antiseptic lotions.

CLOSURE OF THE JAWS is the term applied to a condition in which the lower jaw cannot be opened, at least, not to any extent. It may be due to—1, spasm of the masseter muscle, consequent upon the irritation attending the eruption of a wisdom-tooth for which there is not room; 2, cicatricial contraction, following ulceration of the mucous membrane induced by cancrum oris, syphilis, lupus, the abuse of mercury, &c.; 3, ankylosis of the temporo-maxillary joint; and 4, hysteria. *Treatment.*—When dependent upon the eruption of a wisdom-tooth, the tooth itself, or under some circumstances the second molar, must be extracted. When dependent upon cicatricial contractions, the forcible opening of the mouth by a screw-gag and maintaining it open by a cork placed between the teeth will, in slight cases, suffice. In other instances I have found division of the cicatricial bands, and subsequently keeping the jaws separated, successful, although this proceeding does not appear to have always answered in the hands of others. When the bands are very dense or the closure depends upon ankylosis of the temporo-maxillary joint, a new articulation must be made by dividing the ramus of the jaw and removing a wedge-shaped piece of bone in front of the cicatricial contractions.

NECROSIS OF THE JAWS.—Necrosis is more common, and when it occurs, more extensive in the lower than in the upper jaw, a fact due in part to the poorer blood-supply of the former, and in part to the predilection of necrosis for compact rather than for cancellous bone. Though the necrosis may affect the whole of the jaw, it is more often limited to the alveolar process or to the anterior wall. The teeth may loosen and fall out; but at times they retain their connection with the gums and remain *in situ* after the removal of the sequestrum. The *causes* of necrosis of the jaw, as of necrosis elsewhere, generally depend upon inflammation of the periosteum or bone, which in the case of the jaw appears especially to be induced by the fumes of phosphorus, the abuse of mercury, carious teeth in strumous subjects, syphilis, the exanthemata, cancrum oris, and lastly, injury, as in extracting a tooth. *Phosphorus-necrosis* is generally believed only to affect the subjects of carious teeth, but some maintain that it is a local manifestation of a general phosphorus-poisoning. It is much less common since the amorphous form of phosphorus has been used for making matches. The production of new bone in necrosis of the lower jaw, is generally extensive; and there are several specimens in St. Bartholomew's Hospital Museum showing almost complete reproduction of the whole jaw. In the upper jaw new bone is not formed after complete removal. In phosphorus-necrosis a characteristic pumice-like deposit of new bone is formed. *Symptoms.*—Necrosis generally begins with severe pain and deep-seated swelling, which may at first be mistaken for toothache or alveolar abscess, followed by suppuration and bursting of the abscess, either in the mouth or externally on the face, and the formation of sinuses. The breath, as a rule, is horribly fœtid, and there is sharp constitutional disturbance, which in phosphorus-necrosis is sometimes excessive, and may end in septicæmia or pyæmia. On probing the sinus, dead bone is detected. This sign will usually distinguish necrosis from the creeping form of epithelioma, for which, especially in the upper jaw, it is apt to be mistaken. *Treatment.*—The bone as soon as loose should be removed, if possible, through the mouth. In the meantime the parts should be kept aseptic by syringing with Condy's fluid or carbolic lotion, or by insufflation of iodoform, incisions being made through the periosteum to ensure a free drain, or Cargill's respirator may be worn to neutralize the fœtor. Internally, tonics and stimulants and nourishing diet should be given, and iodide of potassium if there is a syphilitic taint.

TUMOURS OF THE UPPER JAW may be cystic or solid, and the latter innocent or malignant; whilst cysts may likewise occur in the malignant solid tumours.

Cystic tumours may be produced—1. In connection with the fang of a carious tooth. 2. By an error in development of the enamel sac covering the crown of the tooth (*dentigerous cysts*); and 3. By obstruction of a mucous follicle in the lining membrane of the antrum. These cysts usually contain a serous, gelatinous, or a brownish fluid in which cholesterine is often found. The condition known as *dropsy of the antrum*, and formerly believed to depend merely upon an accumulation of fluid in that cavity owing to the occlusion of the opening into the nose, would appear to be due to one of these mucous cysts so distended as to completely fill the antrum.

Dentigerous cysts, which may also occur in the lower jaw, are due to an error in the development of the enamel sac, usually of the permanent teeth. They differ from the ordinary dental cyst depending upon the irritation of a decayed fang, in that in the latter the fang will generally be found projecting into the cyst, whereas in the dentigerous variety, the crown alone, which has not been cut, or in some cases the whole tooth, will be found in the cyst.

Solid tumours may spring from the periosteum covering the exterior of the bone, or from the mucous or the periosteal lining of the antrum. They may have a fibrous, cartilaginous, osseous, myxomatous, adenomatous, sarcomatous or carcinomatous structure; but fibrous and sarcomatous tumours are the most common, whilst cartilaginous are very rare. Ossification of the sarcomatous growths is of occasional occurrence. They may be closely simulated by tumours of a like diversity of structure growing from the malar bone, the spheno-maxillary fossa, or the base of the skull.

Symptoms and diagnosis.—Clinically, it is not always possible to determine the exact structure of these tumours, nor is it essential, the surgeon's aim being rather to distinguish the solid from the fluid, and the innocent from the malignant, and to make out their origin and present attachments. When the tumour, whether cystic or solid, innocent or malignant, begins in the antrum, it sooner or later fills that cavity, and then in its further growth causes its walls to bulge in various directions. Thus, the bulging of the anterior wall causes a swelling on the cheek, of the internal wall an obstruction in the nose, of the inferior wall a depression of the palate, and of the superior wall a protrusion of the eye. A rounded projection on the cheek; a sensation of fluctuation felt through the anterior wall of the antrum with the finger in the mouth, or egg-shell-like crackling produced by the yielding of the thinned and partially absorbed walls; the presence of a carious tooth, or the absence of one of the teeth in the series (in the case of a dentigerous cyst) will point to the cystic nature of the swelling, and puncture with a trocar and cannula will clear up any doubt. Should the tumour be solid, it will probably be *innocent* if of slow growth and there be absence of pain and glandular enlargement, non-implication of the skin, and non-infiltration of surrounding parts; but *malignant* if of rapid growth and there is severe pain, early escape through the walls of the antrum, implication of the skin, involvement of glands, and protrusion of a fungous mass in the mouth, nose, or on the cheek. In malignant disease, moreover, the patient will probably be either young in the case of sarcoma, or advanced in life in the case of carcinoma, but if a small piece of the growth can be obtained, a microscopical examination will settle the point. When the growth springs from the malar bone, it may either project forwards on the cheek, or into the mouth between the cheek and the bone, and the bulging of the walls of the antrum will be absent. When it arises from the spheno-maxillary fossa or base of the skull, it will commonly project into the naso-pharynx, where it may be detected by the finger or rhinoscope, while the whole maxillary bone will be pushed forward. It should not be forgotten, however, that tumours beginning in the antrum, especially the fibrous and sarcomatous, encroach upon the surrounding parts, and conversely, that the cavity of the antrum may be invaded by growths not primarily connected with it; so that when a tumour in this region has attained a large size it may be impossible to determine its origin, or, indeed, the whole of its actual attachments.

Treatment.—For cystic tumours, excision of a portion of the wall from within the mouth will generally suffice, if a free drain is subsequently ensured. At times the thinned walls of the cyst may be crushed together by the fingers with advantage. Where the cyst is associated with a solid growth, the latter may sometimes be scraped away, otherwise the upper jaw must be partially or completely removed. When the tumour is *solid*, and of an *innocent* nature, and entirely confined to the antrum, it may be removed by excision of the superior maxilla, but as a rule no more of the bone should be taken away than is absolutely necessary, the orbital plate and hard palate being preserved if possible. When the tumour arises behind the bone, there is often great difficulty in getting it away, as its attachments may be more extensive than is imagined. If thought advisable to attempt its removal this may be done by excising the superior maxilla, and clearing away the growth; or the maxilla may be turned outwards, the growth removed, and the bone replaced (*Langenbeck's method*).

When the growth is *malignant* and confined to the antrum, the superior maxilla may also be excised; but when it has invaded the surrounding parts, it becomes not only a question whether it can be completely got away, but whether the immunity from its return will not be of too short duration for the patient to undergo the risk of the operation.

COMPLETE EXCISION OF THE UPPER JAW.—Having extracted the central incisor tooth on the diseased side, make an incision down to the bone in the direction shown by the dark line in Fig. 265. Dissect back the flap thus marked out from the bone, securing the larger arteries as they are divided. Make a longitudinal incision through the mucous membrane lining respectively the floor of the nose and roof of the mouth as far back as the soft palate, and then a transverse one along the junction of the soft with the hard palate on the diseased side. Now pass one blade of the long jaw-forceps into the mouth and the other into the nose, and divide the alveolar process and hard palate; cut through the nasal process of the superior maxilla, and then through the malar bone, carrying the forceps into the spheno-maxillary fissure. Seize the bone with lion-forceps, and wrench it away from its remaining attachments. The internal maxillary, or any other large artery, should be tied, and hæmorrhage from smaller vessels restrained by plugging the wound with strips of iodoform gauze. When the bleeding has stopped, any growth that may remain should be cut away or destroyed with the actual cautery. Unite the edges of the wound with horse-hair sutures, and the lip with hare-lip pins. Healing occurs readily and with little deformity. An obturator with false teeth should subsequently be fitted to the mouth.

PARTIAL EXCISION OF THE UPPER JAW usually consists in leaving the orbital plate, and is done by dividing with a key-hole saw the front wall of the antrum along the margin of the orbit, and completing the operation as above described.

RESECTION OF THE UPPER JAW (*Langenbeck's operation*) consists in turning the maxillary bone outwards so as to get at a tumour behind it, and then replacing the bone. As the connections of the bone along its outer part are left intact, its vascular supply is not completely cut off, and it soon forms fresh adhesions when placed back in position.

TUMOURS OF THE LOWER JAW, like those of the upper, may be cystic or solid, innocent or malignant. *Cystic tumours*, as in the upper jaw, may be developed in connection with an uncut tooth (*dentigerous cysts*), or around the fang of a decayed tooth. They are then unilocular. *Multilocular cystic tumours* have a marked predilection for the lower jaw. They are believed to be due to invasion of the jaw by epithelium of uncertain origin but probably derived from the enamel germ or dental groove. The epithelial masses undergo degeneration, leading to cysts often of considerable size. These tumours grow very slowly, and may gradually destroy the whole bone, reducing it to a mere shell, but if completely removed do not recur locally. They never affect the glands or become disseminated. The *solid tumours* may grow from the periosteum covering either the outer or the buccal aspect of the jaw, or from the interior of the bone which they then expand around them. The osseous tumours usually take the form of exostoses, and are not uncommon about the angle of the jaw. The more regular shape of the lower jaw, its compact structure, the absence of a cavity like the antrum, its more isolated condition, and the absence of surrounding cavities like the nose, orbit, and spheno-maxillary fossa, make the diagnosis of tumours in it more easy. The signs are similar to tumours of the upper jaw, which see (p. 547).

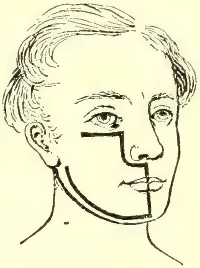


FIG. 265.—Lines of incision for removal of upper and lower jaw.

Treatment.—Cystic tumours are best treated by free incision, and, if large, by excision of a portion of their wall. In the case of the multilocular cysts the whole or part of the jaw may be removed. In excising solid innocent tumours no more of the bone should be sacrificed than is necessary to extirpate the disease; and such removal, when possible, should be done from within the mouth. Myeloid growths springing from the interior of the bone may often be enucleated, and not recur for many years, or not at all. Where the tumour is large and encroaches upon the ramus, the affected half of the jaw, or if both halves are affected, the whole jaw, should be removed by disarticulation, since, if the ramus is merely sawn across, leaving the coronoid process and condyle, these are apt to be drawn forward by the temporal and external pterygoid muscles and prove a constant source of annoyance. When the growth is malignant or of large size, and the skin and neighbouring soft parts are implicated and the glands extensively involved, no operation, as a rule, is admissible. Cysts developed in connection with solid growths may be laid open and the tumour scraped away, or part or the whole of the jaw, if the growth is malignant, may be removed.

Excision of the lower jaw.—Having extracted the central or the lateral incisor tooth, make an incision down to the bone (in the way shown in the black line in Fig. 265) through the lower lip, along the lower border of the jaw, and thence up the ramus, nearly but not quite to the lobule of the ear to avoid the facial nerve, tying both ends of the facial artery as it is cut. Dissect up the flap thus formed from the bone, and divide the bone with saw and forceps opposite to where the tooth has been extracted. Seize the bone with the lion-forceps, drawing it outwards and upwards, and divide the soft tissues on the inner surface with a narrow-bladed scalpel, keeping close to the bone to avoid the gustatory nerve and the submaxillary gland. The origin of the genio-hyo-glossus should be spared if possible, as otherwise the tongue tends to fall backwards, and has before now caused suffocation. If this muscle must be divided, pull the tongue forward by a ligature through its tip. Next separate the internal pterygoid, depress the jaw, and divide the temporal muscle at its insertion into the coronoid process. Open the articulation from the front, divide the external pterygoid, and carry the knife beyond the condyle, taking care not to rotate the jaw outwards lest the internal maxillary artery be stretched round the neck of the condyle and be thus torn or divided.

DISEASES OF THE NOSE, NASO-PHARYNX, AND ACCESSORY CAVITIES.

Acne rosacea is a dilated or congested condition of the capillaries of the nose, usually accompanied in its later stages by hypertrophy of the sebaceous follicles. It is attributed to indigestion, exposure to cold, sexual disturbance, or the abuse of alcohol, and is most common in women. *Treatment.*—Remove the cause, regulate the diet, and attend to the general health. Locally apply sulphur ointment or perchloride of mercury lotions. In severe cases the dilated vessels may be incised and the resulting hæmorrhage restrained by touching them with perchloride of iron, but only small portions of the disease should be thus treated at a time.

LIPOMA NASI is an hypertrophy of the skin, subcutaneous tissue, and sebaceous follicles of the nose, and not, as the name implies, an increase in the fatty tissue. It is characterized by the formation of irregular pendulous lobe-like masses, usually situated on the tip and alæ of the nose, and often of a bluish-red colour. It occurs in elderly men, generally as the result of alcoholism. *Treatment.*—The masses should be shaved off, care being taken not to cut through the cartilages into the nostrils, and the parts left to granulate. The treatment is usually very successful.

LUPUS, RODENT ULCER AND EPITHELIOMA may all attack the exterior of the nose, but require no special description here.

GUMMATA over the nasal bones are not uncommon. They present the characters of gummata in other situations, and give rise to boring nocturnal pains. The interior of the nose is generally affected at the same time.

EPISTAXIS OR BLEEDING FROM THE NOSE is a symptom of many and various conditions. Thus—1. In the young it often appears to occur spontaneously from congestion of the mucous membrane, and is especially common in girls about the age of puberty. 2. In the plethoric it may be due to the congestion of the brain or liver, and then appears to give relief to the over-full vessels. 3. In the old or cachectic, on the contrary, it may be due to a poor or watery condition of the blood, such as is present in cirrhosis of the liver, heart-disease, granular kidney, &c. 4. It may also occur in scurvy, some forms of fever, and in the hæmorrhagic diathesis. 5. It is common after blows or other injuries of the nose; and 6. It may be a symptom of fracture of the base of the skull, of an angioma of the septum, of tuberculous ulceration, or of adenoid, fibrous, or malignant growths in the nose or naso-pharynx. The *symptoms* are usually evident. The blood generally comes from one nostril, occasionally from both; but it may pass through the posterior nares and be swallowed, and being afterwards vomited, simulate hæmatemesis; or it may irritate the larynx, cause cough, and may then be mistaken for hæmoptysis. On looking into the mouth in such cases, however, the blood will be seen trickling down the back of the throat; whilst it may also be apparent on examining the nose with a speculum. In some cases the blood may be seen flowing from a small vessel on the anterior and lower part of the septum (*seat of election*). The *treatment* will depend upon the cause. Spontaneous hæmorrhages occurring in the young, except as the result of the hæmorrhagic diathesis, generally stop of their own accord, and require no special treatment beyond those remedies common in domestic use. When due to congestion and apparently salutary, the bleeding should not be too soon checked. In cachectic subjects it is often difficult to control; rest on the back with the arms raised, sucking ice, cold or hot douches, ice to the nose, subcutaneous injections of ergotin (gr. iij.), gallic acid, lead and opium and small doses of ergot or of perchloride of iron, may then be tried. Or pellets of cotton-wool soaked in solutions of cocaine (20%) may be placed in the nostril, or pressure made on the upper lip just below the ala of the nose in order to compress the septal branch of the superior coronary artery from which the blood is said often to be derived. When the blood comes from the *seat of election*, touching the bleeding point with the galvano-cautery will at once arrest the flow. If the hæmorrhage cannot be controlled, the nose should be plugged. The best means of effecting this is by pushing in strips of iodoform gauze with nasal forceps against the index finger of the opposite hand in the naso-pharynx. The end of the strip should be left out on the face and removed within twenty-four hours. The old method of plugging the posterior nares with Bellocq's sound (Fig. 266) is now seldom used.

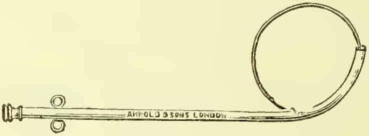


FIG. 266.—Bellocq's sound.

EXAMINATION OF THE NASAL CAVITIES.—For the diagnosis of internal diseases the nasal cavities should be illuminated by the laryngoscopic mirror (Fig. 285) or the electric lamp, the alæ being separated by some form of nasal speculum, of which Duplay's and Fränkel's are the best (Figs. 267, 268). The examination should be made systematically. It is not sufficient to merely introduce the speculum and look at the parts with the head in the position it happens to be at the time. The head should be thrown back to gain a view of the middle turbinal body and upper portion of the nasal chambers; then held straight to inspect the inferior turbinal body and corresponding part of the septum; next the chin should be depressed that the floor may be examined and the patency of the inferior meatus ascertained. Finally the head should be rotated to and from the light the better to see the lateral boundaries of each nasal chamber. The posterior part of the nasal cavities can be explored by the finger passed behind the palate, or by a small mirror passed to the back of the throat (*posterior rhinoscopy*). For detecting necrosed bone the nasal probe may be used.

NASAL CATARRH, RHINITIS, CORYZA, or inflammation of the mucous membrane of the nose, may be acute or chronic.

Acute catarrh, *coryza*, or *cold in the head*, will be found treated of in works on Medicine.

Chronic nasal catarrh or rhinitis is most common in the young, especially in children of a strumous habit. As exciting causes may be mentioned oft-repeated attacks of acute catarrh, adenoid vegetations in the vault of the pharynx, nasal stenosis, deflected septum, the irritation of noxious vapours or dust, the abuse of spirits, snuff-taking, &c. Several forms, all of which are believed by some surgeons to be different stages of the same disease, have been described. They will be classed here under the three heads of 1, the simple; 2, the hypertrophic; and 3, the atrophic, which is generally attended with fœtor. 1. The *simple* form is characterized by a thin mucous or muco-purulent discharge, and a congested appearance of the mucous membrane, but is unattended with any thickening, or formation of crusts, or with fœtor. If neglected, it is apt to pass into the next variety. 2. In the *hypertrophic* the mucous membrane, especially over the turbinated bones, is greatly swollen and congested, and infiltrated with inflammatory material; while the glands are stimulated to excessive secretion, and pour out a muco-purulent discharge. It is characterized by symptoms of nasal obstructions, viz., stuffiness or blocking of the nose, nasal tone of voice, constant need to blow the nose, a vacant expression of countenance acquired by keeping the mouth open, trickling of the discharge down the pharynx and subsequent hawking of it up by coughing, and sometimes deafness from the spread of inflammation to the Eustachian tube. At times certain reflex phenomena re present, such as spasmodic cough, asthma, and even epilepsy. The alæ of the nose often appear thickened and the inferior urbinated bodies greatly enlarged. On posterior rhinoscopic xamination granular pharyngitis is frequently discovered, with ncrease of the glandular tissue of the vault of the pharynx; whilst he hypertrophied posterior ends of the inferior turbinated bodies

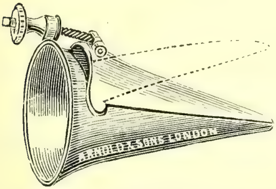


FIG. 267.—Duplay's nasal speculum.

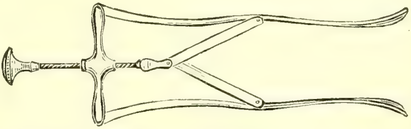


FIG. 268.—Fränkel's nasal speculum.

may at times be seen almost completely blocking up the choanæ in the form of globular, irregularly-furrowed tumours (Figs. 269, 270). This variety is said by some, but without sufficient evidence I think, to pass, after it has lasted some years, into the third variety. 3. *Atrophic rhinitis*, sometimes called *dry* or *fœtid* catarrh, and by some *ozæna*, is apparently due to the shrinking of inflammatory new formation infiltrating the tissues, and the consequent atrophy of the mucous membrane and the greater or less destruction of the glands. It is characterized by the nasal cavities appearing preternaturally large, so much so that in some cases the wall of the pharynx and Eustachian tube may be seen on looking through the nostril. The turbinated bodies appear decreased in size, and the mucous membrane is atrophied and paler than natural and covered with hard yellowish-green adherent crusts. Generally, though not invariably, the disease is attended with a horrible fœtor, which is usually thought to be due to the decomposition of the discharge beneath the crusts, the discharge being secreted in too small quantities and too thick to allow of the throwing-off of the crusts. By some the fœtor is believed to be due to the retention of the secretions in some of the sinuses communicating with the nose. In all forms an important point to remember is that ulceration does not occur.

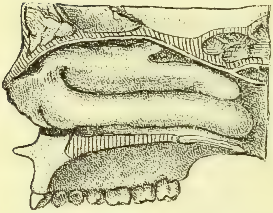


FIG. 269.—Hypertrophic nasal catarrh.
(St. Bartholomew's Hospital Museum.)

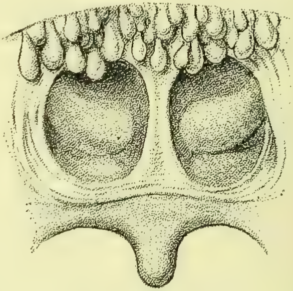


FIG. 270.—Hypertrophy of the posterior ends of the inferior turbinated bodies, with adenoid vegetations in the vault of the pharynx.

Treatment.—In the early stages much can be done in the way of treatment, and by perseverance a cure may be obtained. In the atrophic variety relief from the distressing symptom of fœtor only can be expected. In all forms the general health must be attended to. Thus, in the strumous, cod-liver oil or maltine, and the syrup of the iodide or phosphate of iron, are indicated. Locally, in the simple and milder forms of the hypertrophic, the treatment consists in cleansing the parts and then applying astringents; the cleansing may be accomplished by simply blowing the nose, or if this is not sufficient, a cleansing fluid must be used. There are many of these. The one I have found most useful is that known as Dobell's solution, but peroxide of hydrogen is perhaps equally as good. The cleansing lotion should not be used, as is so frequently done, by Thudichum's nasal douche, as by its means the deeper recesses and upper portions of the nasal fossæ cannot be reached, and not only may much harm be done to the mucous membrane of the nose, but inflammation of the middle ear may be set up. The solution is best applied in the form of a coarse spray, either by the anterior or posterior nasal spray-producer worked by double handballs (Fig. 271). When thoroughly cleansed, astringent or sedative solutions —best in the form of sprays—should be applied, and of these may be mentioned tannic acid, sulpho-carbolate and iodide of zinc or menthol, eucalyptol (ʒss. to ℥j.), terebene (gr. xx. to ℥j.), cocaine and thymol (gr. x. to ℥j.), dissolved in liquid petroleum, a better vehicle than water for intranasal medication. Astringents or iodoform may also be applied in the form of powders by the insufflator, or in the form of gelatine bougies. Where there is great hypertrophy, the hypertrophied tissues must be destroyed by the local application of chromic acid or the galvano-cautery; or the ends of the inferior turbinated body if much enlarged may be removed by Jarvis' cold wire snare, by the galvanic écraseur, or by the ring knife or spoke-shave. At times the whole of the turbinated body may be removed with advantage. If the septum is deflected, it must be straightened; and if adenoid growths are present, they must be removed. In the atrophic form, little more can be done than cleansing and disinfecting the cavities by lotions of carbolic acid, borax, aristol (ʒss. to ℥j.), and the like; whilst the mucous membrane may be stimulated to secretion by the use of Gottstein's nasal tampons, or by the insufflation of sanguinaria, galanga, &c. Cubebs internally is often of service.

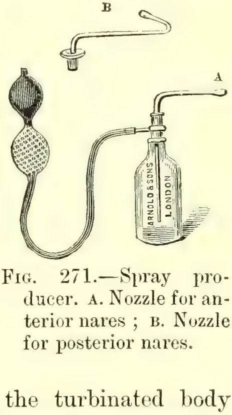


Fig. 271.—Spray producer. A. Nozzle for anterior nares; B. Nozzle for posterior nares.

Turbinal erection, *i.e.*, transient and oft-recurring congestion of the turbinal bodies is very common. The patient complains of intermittent attacks of obstruction to free nasal breathing, especially at night or on entering a hot room, and of an attending flow of a watery fluid from the nostrils. At times there is excessive sneezing. On examination the turbinals are seen enlarged, but the enlargement may be distinguished from hypertrophy by the turbinals dimpling when touched with a probe and becoming smaller when painted with cocaine. Turbinal erection is a common symptom in the condition known as *Hay Fever*. Touching the turbinals in two or three places with the galvano-cautery will generally effect a cure, and even in hay fever often gives great relief.

TUBERCULOUS ULCERATION sometimes occurs. It may lead to necrosis of the bone, falling in of the nose, and much deformity. Constitutional remedies, as cod-liver oil, must be given, and the parts cleansed by lotions, application of iodoform, lactic acid, &c. When obstinate, scraping the part with a Volkmann's spoon, and removal of the dead bone, is the treatment indicated.

SYPHILITIC AFFECTIONS of the nose. In the early stages of syphilis, catarrhal inflammation and mucous tubercles are often met with, especially in infants, in whom they give rise to the obstructed and noisy respiration popularly known as snuffles. Later, extensive ulcerations, gummata followed by deep ulcers, necrosis or caries of the bones and cartilages, destruction of the septum with falling in of the nose and perforation of the palate may occur, and when combined with destruction of the soft tissues and skin, are productive of great deformity. When a small portion of bone in the deeper recesses is necrosed, it may not always be easy to find, but may be suspected by the continuance of a muco-purulent discharge and the fœtor so peculiar to dead bone, the presence of foul ulcers, the history or constitutional signs of syphilis, and the absence of signs of hypertrophic or atrophic catarrh. Often the bone may be struck on examination with the nasal probe. *Treatment.*—Iodide of potassium should be given in large doses, combined, if necessary, with quinine or bark, and at times with mercury. Locally the parts should be cleansed and disinfected by the application of carbolic or other sprays, and when dead bone can be detected it should be removed, if loose, through the anterior nares or from behind the palate by forceps; but sometimes it may be necessary for obtaining a sufficient exposure to resort to the method of Rouge, or to cut through the upper lip and turn aside the ala of the nose. In congenital syphilis the administration of small doses of grey powder, followed by iodide of potassium and cod-liver oil, is productive of the most happy results. In the ulcerative form, iodide of potassium in large doses should be given.

LUPUS, though far more common on the exterior of the nose, may sometimes be met with in the interior. It then generally attacks the cartilage of the septum, leading to perforation. It is attended with a fœtid discharge. The lupous patch is covered with broad, flattened, brownish scales or crusts, and surrounded with reddish tubercles. On the removal of the crusts the ulcerated surface is found soft and friable. *Treatment.*—Cod-liver oil, arsenic, and the complete destruction of the affected tissue by caustics, lactic acid, or by scraping, is the proper treatment.

RHINOLITHS OR NOSE STONES may occasionally form in the nose from the deposition of phosphate of lime and mucous upon either a foreign body which has become lodged in the nose, or a portion of hardened secretion. They give rise to inflammation, swelling of the mucous membrane, and a fœtid discharge, and have been mistaken for osteomata and even for carcinomata. When detected they should be removed by forceps, or if too large for this, first broken by the nasal lithotrite.

For the treatment of foreign bodies in the nose, see p. 348.

POLYPI.—Three forms are described—the gelatinous, the fibrous, and the malignant.

1. *Gelatinous or mucous polypi* most frequently spring from the mucous membrane lining the middle meatus, often forming a cluster around the anterior end of the middle turbinal body, rarely from the roof of the nares, and scarcely ever from the septum. They usually have a myxomatous structure, that is, they consist of delicate connective tissue infiltrated with large quantities of mucin containing round and stellate cells, and are covered with ciliated epithelium. They are usually multiple, sessile or pedunculated, and of an oval, pyriform, or lobulated shape. The usual *symptoms* are a feeling of stuffiness in one or both nostrils, worse in damp weather, a nasal tone of voice, and a mucous discharge. Certain reflex symptoms, such as asthma, cough, &c., are also occasionally present. At times they are attended with partial or complete loss of smell (*anosmia*). On inspection, they appear as pinkish or greyish-white, semi-translucent, gelatinous, moveable bodies, soft and dimpling when touched with a probe. When high up, or far back in the nasal cavities, the speculum or rhinoscope may be necessary to detect them. With the rhinoscope I have often succeeded in detecting a polypus at the posterior nares that had been previously overlooked. When a polypus approaches the anterior nares it is liable through irritation as by the finger to become inflamed and lose its gelatinous appearance; it may then be mistaken for a sarcoma, unless care is taken to examine its remoter and unirritated portions. Nasal polypi are sometimes associated with polypi in the antrum and frontal sinuses.

Treatment.—Gelatinous polypi are best removed by the galvano-cautery, as this is attended with less pain and with practically no hæmorrhage. The parts should be previously sprayed with a 20 per cent. solution of cocaine, and after the removal of the polypi the surface from which they sprang should be touched with the galvano-cautery to prevent a recurrence. If the cautery is not at hand, the polypi may be removed by the cold wire snare or be twisted off by the ordinary polypus forceps. When they project into the naso-pharynx, they may be removed, either with the galvano-cautery loop passed through the nose or by the forceps introduced behind the palate. A snuff of tannic acid, used subsequently to their removal, is said to prevent recurrence, but I have not found it of much service.

2. *Fibrous polypi* actually arising from the interior of the nasal cavities are very rare. Those commonly met with usually spring from the basilar process of the occipital bone or body of the sphenoid, that is, from the roof of the naso-pharynx, and then ought properly to be called *naso-pharyngeal*, as it is only after they have attained some size that they encroach upon the nasal cavities. They consist of fibrous tissue not infrequently mixed with spindle cells, and often contain large thin-walled blood-vessels, which give them an almost cavernous structure (*fibro-angiomata*). The mucous membrane covering them is also very vascular. They may be sessile or broadly pedunculated. As they increase in size, they invade and displace the surrounding bones, making their way into the nasal cavities and into the pharynx, and projecting below the palate and even into the interior of the skull. They are usually met with in young adult life. The *symptoms* are obstruction of one or both nostrils, a mucous and often foul-smelling discharge, repeated attacks of hæmorrhage, deafness, obstruction to breathing and sometimes to swallowing, and in the later periods of the growth the characteristic deformity of the facial bones known as *frog-face*. They may be seen on looking into the nostril from the front, or by the rhinoscopic mirror from the back, or may be felt by the finger behind the soft palate. If not removed, they may end fatally from hæmorrhage, although they have apparently a tendency to undergo atrophy as the patient gets older. *Treatment.*—The removal of these growths is attended with profuse hæmorrhage. It is safer therefore to fully expose them by a preliminary operation. If chiefly confined to the naso-pharynx, the soft palate should be split, and the two halves held aside by silk ligature, whilst if more room is required part of the hard palate may be cut away after reflecting the muco-periosteum (*Nélaton's operation*). I have employed this method in several cases and found that it gives an excellent exposure of the growth. When encroaching chiefly on the nose, a good exposure may be obtained by dividing the lip in the middle line, and turning it to one side with the ala of the nose; or if more room is required, the superior maxilla must be removed. Rouge's operation of turning up the upper lip and the cartilaginous portion of the nose after division of the septum, and the operation of Langenbeck of turning the maxillary bone outwards on the cheek, and then replacing it after removal of the growth, have their advocates. My experience of these last-mentioned procedures is

not very favourable. The exposure obtained by the former is no better than that gained by turning back the ala; and the shock and hæmorrhage attending the latter renders it very dangerous. Many other methods and modifications of the above have been proposed, but for an account of these a larger work on surgery must be consulted. Having well exposed the growth it should be rapidly gouged away with the raspatory, or it may be removed with the écraseur or cutting forceps, and the base destroyed by the actual or galvano-cautery. The naso-pharynx may then be plugged with iodoform gauze, the ends of the strips being brought out through the nose, and removed through this passage after twenty-four hours. At the end of the operation the palate should be united, the lip sutured or the parts replaced, according to which method of exposure has been practised.

3. *Malignant polypi.*—Sarcomatous and cancerous tumours may arise both in the nasal cavities and naso-pharynx, and then constitute what are called malignant polypi. They give rise to symptoms similar to those of the fibrous polypi already described, but their growth is more rapid, and they quickly infiltrate surrounding parts and involve the neighbouring glands. They may occur both in the young and in the old. If a small piece can be removed, the microscope will reveal its nature. *Treatment.*—When the growth can be got completely away, early and free extirpation by one of the methods above described is the only treatment.

OZÆNA is a term which has been used very loosely by authors. By some it has been applied to all diseases of the nose attended with a foul-smelling discharge, whilst by others it has been restricted to the fœtid form of atrophic nasal catarrh. The term, therefore, as designating a disease, is misleading, and should be discontinued in this sense. For purposes of diagnosis it may be mentioned that it is a prominent symptom in the following affections of the nose—1, atrophic nasal catarrh; 2, necrosis and caries, whether of syphilitic or other origin; 3, tuberculous, syphilitic and lupoid ulceration of the mucous membrane; 4, foreign bodies and rhinoliths in the nasal cavities; 5, purulent catarrh of the antrum or one of the other accessory sinuses; and 6, some forms of new growth.

DISEASES OF THE SEPTUM NASI.—*Hæmatomata or blood tumours* are occasionally met with as the result of injury. The blood is extravasated between the cartilage and the soft tissues, generally on both sides of the septum, causing in both nostrils a fluctuating circumscribed swelling which may be readily distinguished from abscess by its coming on immediately after the injury and by the absence of signs of inflammation. It should not be opened unless it suppurates, as the blood will become slowly absorbed. It sometimes appears to be associated with fracture of the septum.

Abscesses of the septum are not very common. They may be due to injury or the breaking down of a gumma or hæmatoma, but occasionally occur without any apparent cause. When acute they may lead to perforation of the septum. The parts are hot, red, and swollen, and fluctuation may soon be detected. A free and early incision should be made.

Gummata of the septum occasionally form beneath the perichondrium in the course of syphilis. They are readily dispersed with iodide of potassium, but if neglected ulceration ensues and may lead to necrosis and perforation of the septum and to destruction of the bones which may sometimes be so extensive as to cause falling in of the bridge of the nose. The ulcers are characteristic, being deeply excavated, foul, covered by greenish-black sloughs, and surrounded by a bright shining areola of inflammation.

Tubercle of the septum occurs in two forms—the *hyperplastic* and the *ulcerative*. In the former a small, readily bleeding, red swelling is seen, in the latter a shallow, yellowish-grey ulcer. Both forms are usually situated near the anterior part of the septum and are nearly always associated with tubercle in other parts of the respiratory tract. Removal by excision, scraping, or the application of lactic acid is the best local treatment.

Deflection of the septum to one or other side may occur as the result of an injury, or as a congenital malformation. It appears as a swelling projecting into and obstructing one of the nasal cavities, whilst in the other cavity a corresponding depression is seen. The inferior turbinal body on the side of the concavity is often much hypertrophied. The deflection is generally attended with some lateral deviation or even depression of the lateral cartilages, and frequently gives rise to chronic nasal catarrh, deafness, and to many distressing symptoms, such as frontal headache, nasal tone of voice, passage of mucus into the pharynx, &c. *Treatment.*—The septum may generally be forcibly straightened by the forceps shown in Fig. 272, and then retained in position for the first few days, while the parts are becoming consolidated, by the retentive apparatus shown in Fig. 273, and subsequently by ivory or vulcanite plugs (Fig. 274). I have found hollow plugs (Fig. 275) useful in that they do not so completely obstruct nasal respiration. In some instances portions of the prominent septum may be removed by the nasal saw with advantage. Where the lateral cartilages and nasal bones are deviated they can generally be straightened, even after many years have elapsed since the injury. Great force, however, is required, and care must be taken, by properly padding the forceps, not to injure the soft parts. One of the best forms of retentive apparatus then is, perhaps, the mask shown in the accompanying diagram (Fig. 276), since by its means a fixed point is secured to work from. As the mask, however, is irksome to some patients I have more recently, for suitable cases, employed the nasal cap and truss depicted in Fig. 277.

Tumours of the septum. Fibrous cartilaginous and osseous tumours, though rare, occasionally occur, and can be readily diagnosed from a deflection of the septum, by their hard and resisting nature and the absence of a corresponding depression in the opposite nostril. Their removal is the proper treatment.

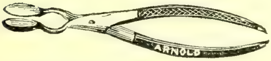


FIG. 272.—Author's forceps for straightening nasal septum.

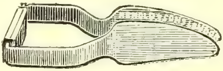


FIG. 273.—Retentive apparatus for deflected septum.

Angiomata or arterial nevi are very rare. They are attended with severe hæmorrhages and bleed profusely if touched. Great care is therefore necessary in their removal, which should be done with the cold or galvano-cautery snare. *Sarcomata and carcinomata* are also met with, as rapidly growing and readily bleeding tumours attended by frequent epistaxis. They should be freely exposed and cut away if not too extensive.

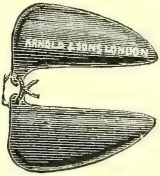


FIG. 274.—Nasal plugs.

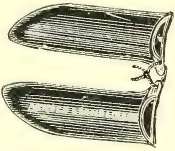


FIG. 275.—Hollow nasal plugs.

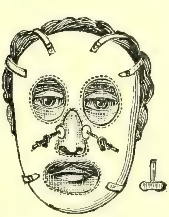


FIG. 276.—Author's nasal mask.

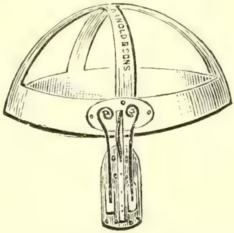


FIG. 277.—Author's fixation cap and nasal truss.

ADENOID VEGETATIONS in the vault of the pharynx are very common in childhood. They are produced by the hypertrophy of the adenoid tissue which is so abundant in this situation, and are frequently met with in connection with enlargement of the tonsils, granular pharyngitis, and nasal catarrh, and if neglected may set up catarrhal otitis and incurable deafness. The chief symptoms to which nhey give rise are deafness, obstruction to nasal respiration, snoring, a nasal or "dead" tone of voice, and a vacant expression of countenance from the child breathing with the mouth half open. To the finger, behind the palate, they feel soft, pulpy, and velvety, "like a bag of earthworms;" whilst in the mirror they appear as pink or reddish, sessile or pedunculated masses more or less obscuring the posterior nares (Figs. 270 and 278). The *treatment* consists in removing them, which may be done in several ways. The softer ones may be scraped away with the nail of the finger behind the palate; those about the Eustachian tubes and side of the pharynx are best extirpated by Meyer's ring knife (Fig. 279) introduced through the nose; and the larger ones, which are situated on the roof and back of the pharynx, by Loewenberg's forceps (Fig. 280) and Gottstein's curette passed behind the palate. The pharyngeal tonsil which is usually hypertrophied in connection with adenoid growths can be readily removed by these forceps.

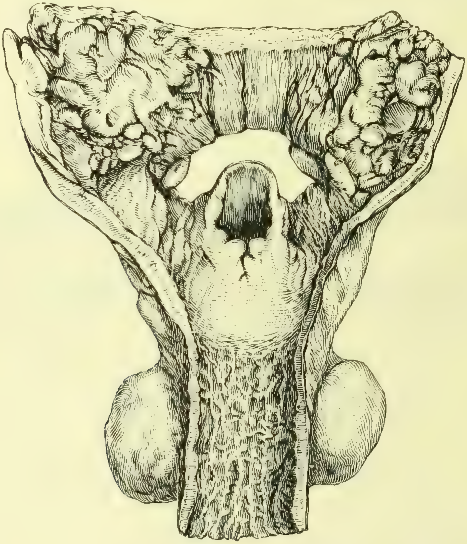


Fig. 278.—The naso-pharynx, pharynx and œsophagus opened from behind to show adenoid vegetations in the vault of the naso-pharynx. (St. Bartholomew's Hospital Museum, No. 1806 *c.*)

Ether followed by chloroform should be given; gas does not afford sufficient time for thorough removal. I have had to repeat the operation when gas has been employed by others. The anæsthetic should not be pushed beyond the "pin-point pupil." Some surgeons recommend the hanging-head position, but this interferes with the complete removal of the growths. I always myself have the head on its side, so that the blood may run into the cavity of the cheek, whence it can be readily sponged away. No after-treatment, beyond compelling the child to breathe through the nose by keeping the mouth closed at night with a bandage, is usually required.

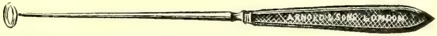


FIG. 279.—Meyer's ring knife.

I never employ the syringe, as I believe it is one of the chief causes of the middle-ear trouble which sometimes occurs after the removal of these growths. As a precaution against cold I always confine the patient to his bed or room for a few days.

THE ANTRUM AND THE FRONTAL, ETHOMIDAL AND SPHENOIDAL SINUSES may be the seat of purulent catarrh. The catarrh may be due to simple extension from the nose or the presence of mucous polypi, or to the irritation of a carious tooth fang. The most characteristic sign is a unilateral discharge of pale yellow pus. This in the absence of a foreign body or rhinolith, necrosed bone, or syphilitic ulceration, is almost pathognomonic of catarrh of one of these sinuses. In catarrh of the *antrum* the discharge is nearly always intermittent, and after a period of retention is often fœtid. The pus usually flows anteriorly from beneath the middle turbinal, and more freely when the head is depressed or laid on the opposite side. Some pain or tenderness may be elicited by pressing on the cheek or on tapping a tooth, but often there is neither pain nor tenderness. On percussion there may be marked dulness, and on placing an electric lamp in the mouth the affected cheek lights up less brilliantly than the other, but an exploratory puncture through the canine fossa, an empty tooth socket, or beneath the inferior turbinal may be necessary to settle the diagnosis. In catarrh of

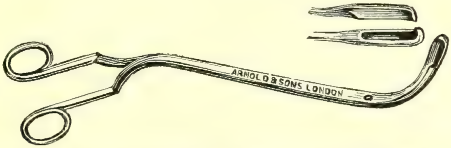


FIG. 280.—Author's modification of Loewenberg's forceps for removing adenoid vegetations.

the *other sinuses* the flow of pus is more or less continuous, and is promoted by the erect position. It may or may not be fœtid. When it comes from the *frontal* or *anterior ethmoidal cells* it flows anteriorly, also from beneath the middle turbinal; when from the *posterior ethmoidal* or *sphenoidal cells* either posteriorly or anteriorly, and then over the middle turbinal. There is usually deep-seated pain at the back of the nose in posterior ethmoidal and sphenoidal trouble, pain in the orbit and forehead in anterior ethmoidal and frontal. Exophthalmos points to ethmoidal or sphenoidal mischief; ptosis, strabismus and sudden blindness to sphenoidal. *Treatment.*—Sprays such as those mentioned at page 555 should first be used to subdue the nasal catarrh. If the discharge still continues an attempt may be made to wash out the antrum or frontal sinus through the nares by the antral or frontal catheter, as the case may be, or, if this fail, they should be opened externally and drained. The *antrum* may be opened and washed out through the nares, the front wall or the alveolus of a tooth. Where the teeth are sound I prefer to open the antrum through the canine fossa, but if a tooth is absent or carious I then perforate through the alveolus after first extracting any carious stump. A tube should be left in the opening to prevent premature closing, and the antrum washed out daily with boric acid lotion and subsequently with sulphate of zinc. If this does not cure the catarrh, the opening should be enlarged and the granular or polypoid surface of the lining membrane should be scraped away. The *frontal sinuses* may be opened by the trephine through their front wall and washed or scraped out and an attempt made to restore the passage, if blocked, into the nose by means of a probe or perforator. The *sphenoidal* or *ethmoidal* sinuses may be drained by cautiously curetting through the nose, or in the case of the *anterior ethmoidal* by a careful incision at the inner angle of the orbit.

Rhinoscleroma is a very rare disease. It has been met with chiefly in Russia, Austria, and Central America. It depends upon the presence of the rhinoscleroma bacillus and is characterised by the formation of smooth, hard, dense, plate-like or nodular masses of tissue beneath the mucous membrane and skin. It usually begins in the interior of the nose and spreads forwards to the upper lip or backwards into the pharynx and may lead to complete stenosis of the nasal cavities and great external deformity. The stony hardness, rigidity, slow growth and absence of pain, inflammation and ulceration make it quite unlike any other disease. *Treatment.*—In the early stages the growth should be freely excised; later something may be done to restore nasal breathing by cutting portions away or by burning a passage with the cautery. Injections of a glycerine extract of the rhinoscleroma bacillus are said to have been attended with some success.

DISEASES OF THE PHARYNX AND ŒSOPHAGUS.

PHARYNGITIS, or inflammation of the pharynx, is commonly of the catarrhal variety (*acute and chronic pharyngitis*), but it may fall chiefly on the glands of the pharynx (*follicular or granular pharyngitis*), or more rarely, may spread deeply and end in suppuration (*phlegmonous pharyngitis*). At times it is attended with deficient secretion and atrophy of the mucous membrane (*pharyngitis sicca*), and occasionally assumes an *erysipelatous* character, and is then generally associated with erysipelas of the face. Here a few words only can be said on the *phlegmonous* form, which, perhaps, more commonly comes under the care of the general surgeon. It is usually the result of an injury. The pharynx is intensely red and swollen, the neck often brawny and œdematous (*Ludwig's angina*), swallowing is difficult or impossible, respiration is laboured, and death may occur in a few days from sudden spasm of the glottis, or from exhaustion and blood-poisoning. The *treatment* consists in inhalations of steam impregnated with carbolic acid; free incisions if pus forms in accessible situations; the administration of fluid nourishment and stimulants, in the form of enemata if the patient is unable to swallow; and the performance of instant tracheotomy if œdematous laryngitis supervenes.

ULCERATION generally occurs in connection with like ulceration of the palate, fauces, and tonsils. (See *Tonsils.*) Here it need only be said that the healing of the ulcers, especially those of the tertiary syphilitic variety, is sometimes productive of great deformity. Thus, 1, the soft palate may become glued to the back of the pharynx; or 2, to the base of the tongue; and 3, the lower part of the pharynx may be narrowed just above the entrance to the larynx, rendering deglutition difficult, and subjecting the patient to the risk of suffocation from the lodgment of food at the constricted part. *Treatment.*—Adhesions between the palate and pharynx can hardly be remedied; but when contraction or *stenosis* of the lower pharynx has occurred, the cicatricial bands should be divided in a backward direction with a guarded knife and recontraction prevented by the daily passage of a bougie. I have found a Ricord's urethrotome answer admirably for making the division. If the introduction of instruments causes much spasm, tracheotomy should be previously performed.

POSTPHARYNGEAL ABSCESS is a collection of pus in the loose cellular tissue behind the pharynx, and is most often met with in children. It is generally chronic, and due to disease of the cervical vertebræ or more rarely of the base of the skull; but it may be acute, and is then usually the result of an injury, as swallowing acids or the impaction of a foreign body, or of the exanthemata, phlegmonous pharyngitis, &c. It sometimes occurs without apparent cause; there is then often a history of syphilis or tubercle. It may break into the pharynx, or at the side of the neck; or even make its way into the mediastinum. *Symptoms.*—Pain, difficulty in opening the mouth, obstructed deglutition and respiration, the presence of a fluctuating swelling at the back of the throat, and more or less swelling about the angle of the jaw. When the abscess is acute, there is commonly some febrile disturbance. *Treatment.*—A vertical incision should be made in the middle line through the posterior pharyngeal wall with a properly guarded knife, the swelling having been previously punctured with a long exploring needle if there is any doubt as to its nature. If opened under an anæsthetic, the head should be in the hanging position or should be turned rapidly to the side to allow the escape of pus through the mouth, as suffocation has occurred through a sudden gush into the air-passages. When it depends upon disease of the spine, if an opening is thought necessary it should be made through the side of the neck behind the sterno-mastoid.

TUMOURS OF THE PHARYNX are rare, though all varieties may occur. When arising in the loose cellular tissue behind the pharynx, the more common situation, they are spoken of as *post-pharyngeal* tumours. The softer varieties closely simulate abscess, but the absence of fluctuation, and of pus on puncture will settle the diagnosis. Innocent growths, when small and unattached to the vertebræ, may be enucleated through a vertical incision over them. The malignant, as a rule, should be left alone.

POUCHES OF THE ŒSOPHAGUS are occasionally met with. They nearly always arise from the back of the tube and at its junction with the pharynx, and as they increase in size, bulge in the neck on one or both sides of the cricoid cartilage. The *symptoms* to which they give rise are regurgitation of undigested food some hours after it has been taken, difficulty in swallowing, and later inanition. A sound can at times be passed into the pouch from the mouth, and food can be squeezed out of the pouch into the œsophagus, the pouch becoming flaccid. The *treatment* consists in removing the pouch through an incision in the neck, and closing the wound in the œsophagus with sutures.

STRICTURE OF THE ŒSOPHAGUS may be due to spasm of the muscular fibres (*spasmodic stricture*), to cicatricial contraction (*fibrous stricture*), or to epitheliomatous or other malignant growths of its walls (*malignant stricture*). Further, stricture may be simulated by compression of the œsophagus from without as by an aneurysm, enlarged thyroid gland, post-œsophageal abscess, or mediastinal tumour; or by a foreign body impacted in the tube, disease at the back of the larynx, &c.

Spasmodic stricture or *spasm of the œsophagus* generally occurs in young hysterical women. The patient may be quite unable to swallow, and a bougie, perhaps, will not pass. The *diagnosis* will then rest on the obstruction existing only at times; on the age and sex of the patient; the presence of other signs of hysteria; but chiefly on the fact that, under an anæsthetic, the bougie, which could not previously be passed, slips down easily into the stomach. The *treatment* should consist in the administration of anti-hysterical remedies; whilst the patient may be persuaded that the bougie has cleared the passage.

Fibrous stricture is generally due to cicatricial contraction following an injury, as swallowing boiling water or corrosive fluids, or the impaction of a foreign body. More rarely it results from the healing of a syphilitic ulcer. At times it appears to be congenital; at other times no cause can be discovered. It may exist at any part of the tube, but is most common in the upper half (Fig. 281). It is much rarer than the malignant form, but is liable to become malignant when it has existed for some time. As the result of the constriction, the tube above the stricture becomes dilated and the muscular coat hypertrophied. The dilatation may be general or pouch-like, in the latter case consisting either of a dilatation of all the coats, or of a hernia of the mucous membrane through the muscular fibres.

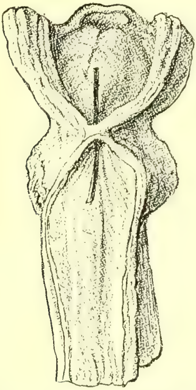


Fig. 281.—Fibrous stricture of œsophagus at region of cricoid cartilage. (St. Bartholomew's Hospital Museum.)

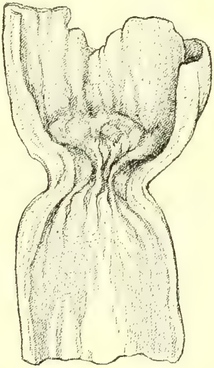


Fig. 282.—Malignant stricture of œsophagus at entrance of stomach. (St. Bartholomew's Hospital Museum.)

Malignant stricture is generally epitheliomatous, and may occur at any part of the œsophagus, but is most common opposite the cricoid cartilage, at the bifurcation of the trachea, and at the cardiac end of the stomach (Fig. 282), situations at which normally slight obstruction to a bolus of food larger than usual exists, and at which "developmental processes are complicated, and where, therefore, errors of nutrition are more likely to occur." Thus, at the cardiac orifice the epithelium changes its character; and where the œsophagus is crossed by the bronchus, the food and air passages were originally one. Epithelioma may begin as a distinct cauliflower-like excrescence springing from one side of the tube; or as a nodular induration of the mucous membrane involving ring-like the whole calibre of the œsophagus. It gradually encroaches upon the lumen of the tube, causing more or less complete obstruction. The growth sooner or later ulcerates, and invades the surrounding tissues, the mediastinum, pleura and glands; and sinuses may form between the œsophagus and the trachea or left bronchus, or open externally when the disease is high up in the neck. The patient, if he does not die of starvation, succumbs to pain or exhaustion, or to hæmorrhage from the laying open of a large vessel, or to pleurisy or pneumonia.

The *symptoms*, common to both the fibrous and malignant stricture, are—1, increasing difficulty of swallowing, first of solids, then of liquids, and finally inability to swallow either; 2, a feeling of obstruction, generally referred to the top of the sternum; 3, regurgitation of food after it has been swallowed for a short time (where the stricture is low down or pouch-like dilatations have formed); 4, a trickling sound on auscultation between the shoulders whilst the patient is swallowing fluid; and 5, progressive wasting and loss of strength. The *diagnosis*, however, can only be made with certainty, and the situation of the stricture ascertained, by the passage of a bougie. But before attemping to pass a bougie, a careful examination of the chest should be made for the purpose of excluding aneurysm as a cause of the symptoms, lest such should be ruptured, as has before now happened. The diagnosis of the malignant from the fibrous stricture will rest on the advanced age of the patient, the absence of any discoverable injury, the presence of blood or foul-smelling discharge on the end of the bougie, a sensation of passing over an ulcerated surface, and the presence of enlarged glands or an indurated mass in the situation of the tube when the stricture occurs in the neck.

Treatment.—In the *fibrous form* the stricture should be gradually dilated by bougies. When the stricture is very tight, a catgut bougie may sometimes by delicate manipulation be insinuated through it; and over this a larger tube may then be passed. When the stricture is very resilient its division posteriorly in the middle line may be called for (*internal œsophagotomy*). When the stricture is situated at the cardiac end, and a well-directed trial at dilatation has failed, gastrotomy may be performed, and the stricture forcibly dilated by the finger or by an instrument passed into the œsophagus from the interior of the stomach. It need hardly be said that so serious an operation should not be lightly undertaken, nor until other means have failed. If the stricture cannot be dilated from the stomach a permanent gastric fistula must be established. In *malignant stricture* dilatation by bougies or tubes, in the way recommended in fibrous stricture, must not be attempted, as the walls of the œsophagus are so softened by the ulceration and disease that great danger of perforation and extravasation into the mediastinum or pleura would be incurred. The methods of treatment then open to us are—1, to pass an œsophagus tube and keep it *in situ*; 2, to perform gastrostomy; and 3, when the stricture occurs in the neck to open the œsophagus in the neck, if possible below the seat of stricture, and stitch the tube to the wound in the skin; or if not possible to get below the stricture, to dilate it from the wound. When a soft tube can be passed and kept *in situ* this appears to be undoubtedly the best treatment. The tube may be introduced through the mouth or nose, and under favourable circumstances will not need changing for a month or more. Occasionally, however, it causes irritation of the back of the tongue or larynx, or of the mucous membrane of the nose. Should this occur, Mr. Charters Symonds' plan may be adopted of passing, by means of a suitable director, a short tube, shaped like a funnel at

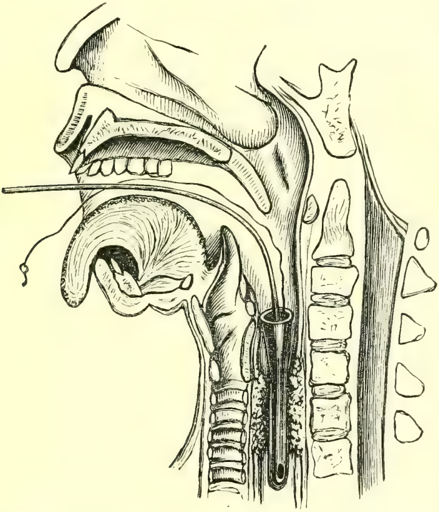


FIG. 283.—Method of placing a Symonds' tube in an œsophagal stricture.

one end, into the stricture, and leaving it there merely attached by a strong string, which is secured to the cheek or ear by strapping (Fig. 283). Care must be taken that the patient does not swallow the string. Should this accident happen during the treatment, an attempt may be made to recover the tube by forceps, &c., or this failing, to push it into the stomach whence it may be removed by gastrotomy. Excellent results have followed the use of tubes; patients have regained flesh, have fairly enjoyed life for some months, and then have died in comparative ease. When a tube cannot be passed, or is not tolerated, the œsophagus, if the disease is high in the neck, may be opened, or if the disease is low down, gastrostomy performed.

GASTROSTOMY is the operation of establishing a fistulous opening into the stomach for the purpose of feeding the patient in stricture of the œsophagus. The operation till recently was usually performed in two stages. In the first stage, the abdomen was opened, and the stomach secured by suture to the abdominal parietes; in the second, which was not performed till from four to six days after the first, the stomach, which by this time had become adherent to the abdominal parietes, was punctured, and a tube introduced. Now, however, the stomach is generally opened at once in order that feeding may be begun before the patient is too far exhausted, but the technique employed is such that a valvular aperture is obtained. In the old direct opening regurgitation was constant and set up troublesome eczema, whilst the mucous membrane was liable to prolapse. Various external incisions are employed; the following I have found as good as any:—an oblique incision (Fig. 305, e) between two and three inches long, is made about an inch below, and parallel with the left costal cartilages, beginning about an inch and a half from the middle line. The sheath of the rectus is next opened, the fibres of the muscle separated, not cut, the posterior layer of the sheath divided, and the peritoneum exposed. Mr. Howse thinks that the fibres of the rectus subsequently play the part of a sphincter to the opening if this is made, as in the older methods, directly into the stomach. All bleeding having been stopped, the peritoneal cavity is opened and the stomach sought below the left lobe of the liver and drawn into the wound. It may be distinguished from the transverse colon by its thick, smooth, and pinkish-red coat and the absence of appendices epiploicæ. The subsequent steps of the operation will now differ according to the method employed. 1. *Howse's method by two stages.*—Two loops of silk are passed through the peritoneal and muscular coat for the purpose of securing a good hold of the stomach whilst the sutures are being introduced, and also for the purpose of steadying it during the subsequent operation of opening it and thus preventing the risk of the adhesions being broken down. The stomach, as near the cardiac end as possible, is now stitched to the parietes by a double ring of sutures, so as to ensure a good inch of the stomach-wall (that between the outer and inner ring of sutures) being in contact with the parietal peritoneum (Fig. 284). The outer ring of sutures is passed first, by carrying the needle, armed with a silk suture, through the serous and muscular coat of the stomach, and the abdominal parietes, a good inch from the edge of the wound. The inner ring of sutures are then passed through the serous and muscular coat of the stomach and the skin and peritoneum of the parietes, and tied. The wound is dressed antiseptically. At the end of from four to six days the stomach will generally be found adherent, and should then be punctured with a long sharp tenotomy knife, while it is drawn well forwards by the silk ligatures left in for the purpose. A No. 6 or 8 English catheter is passed through the puncture, and the wound again dressed antiseptically, the catheter passing through the antiseptic dressings.

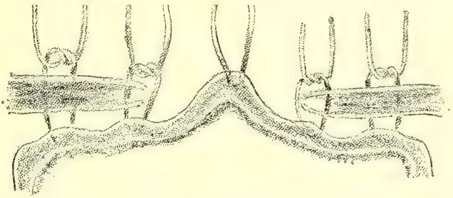


FIG. 284.--Howse's method of suture in gastrostomy.

At first only teaspoonfuls at a time of fluid nourishment should be given; later a tube may be passed, and minced solid food introduced. 2. *Witzel's method.*—After drawing the stomach into the wound, Witzel makes a small opening into it just sufficient to admit a rubber tube about the size of a No. 8 catheter. Two vertical folds of the stomach are next secured by a number of Lembert sutures well over the tube for a distance of about two inches; the gastric end of the tube is thus buried so as to prevent any regurgitation backwards or sideways; the distal end of the tube is then brought out through the upper part of the wound in the parietes to which the stomach is firmly fixed by suture; the rest of the wound is then closed. In this way a valvular passage is made through the coats of the stomach and the patient can be fed through the tube at once. 3. *Franks' method.*—A conical portion of the stomach is drawn into the wound and the base of the cone is fixed to the parietal peritoneum by suture so as to cut off the peritoneal cavity. A second incision three quarters of an inch in length is next made above the rib-margins through the skin only. The bridge of skin "between the two incisions is undermined," and the apex of the stomach pulled under it and out of the second wound. The stomach is at once opened and stitched to the skin. Here also a valvular opening is obtained, and the patient can be fed at once. I have employed this method and can speak well of it, but it is somewhat difficult to drag the stomach, if much contracted, under the bridge into the second wound.

DISEASES OF THE LARYNX.

Physical examination of the larynx.—For the diagnosis and efficient treatment of the diseases of the larynx the laryngoscope is required. To use this instrument place yourself in front of the patient and the light, in the way shown in Fig. 285. Throw the light reflected from the head mirror into the back of the patient's mouth; draw the tongue, held by a towel with the left hand, gently forward, and press the throat mirror, held in the right hand, firmly but gently against the uvula and soft palate. With a little practice an image of the larynx is obtained. Ask the patient to pronounce the sounds *ah*, *ee*, and the vocal cords will come into view. The image of the larynx is of course reversed, the front appearing in the throat mirror as the back. If any difficulty is experienced in obtaining a good view the soft palate and back of the mouth should be sprayed or painted with a solution of cocaine 20 % or eucaine 10 %. If any operation or manipulation is required in the larynx itself, it also should be swabbed with cocaine or eucaine by the laryngeal brush.

Laryngitis, or inflammation of the larynx, may be conveniently divided into—1, acute catarrhal; 2, chronic catarrhal; 3, œdematous; and 4, membraneous laryngitis.

Acute catarrhal laryngitis may be due to sudden exposure to cold or damp, violent exertion of the voice, or inhalation of noxious vapours or impure air; or the inflammation may spread to the larynx from the pharynx; or occur in the course of other diseases, as the eruptive fevers. *Symptoms.*—Soreness of the throat, hoarseness or even aphonia, laryngeal cough, and tenderness on pressure over the thyroid cartilage, accompanied by febrile symptoms. On laryngoscopic examination the parts are seen red and swollen, and the cords do not come together properly. The *treatment* consists in rendering the atmosphere moist by the steam kettle, in inhaling soothing vapours, and abstaining from using the voice; whilst if the attack is very acute, leeches or cold in the earlier stages, may be applied over the thyroid cartilage. Should the inflammation assume the œdematous form, scarification, intubation, or tracheotomy may become necessary (see *Œdematous Laryngitis*).

Chronic laryngitis may be due to exposure to wet and cold, over-exertion of the voice, excessive smoking, inhalations of dust or noxious vapours, syphilis, tubercle, and malignant disease. The mucous membrane appears thickened and indurated and covered with a muco-purulent discharge, whilst the glottis is narrowed in consequence of the thickening of the mucous membrane. *The symptoms* are cough, hoarseness, laryngeal voice, dryness and irritation of the throat, and dyspnœa, varying with the amount of narrowing of the glottis. A variety of chronic laryngitis, in which the mucous follicles are chiefly affected, is known as follicular or granular laryngitis, or clergyman's sore throat, and is frequently associated with a similar condition of the pharynx. *Treatment.*—The application with the brush of a strong solution of nitrate of silver (half a drachm to the ounce, or even stronger), absolute rest of the voice, residence at a suitable spa, avoidance of all sources of irritation, and appropriate remedies if there is any specific disease.

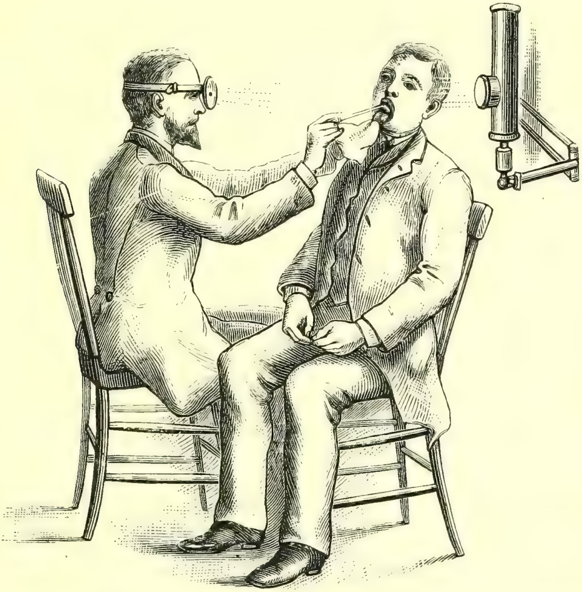


FIG. 285.—Method of using the laryngoscope.

Œdematous laryngitis or œdema of the glottis.—In this form there is an effusion of serous fluid into the submucous tissue of the larynx, especially that about the aryteno-epiglottidean folds (Fig. 286). But the œdema does not extend below the vocal cords, as the mucous membrane is tightly attached to them without the intervention of any submucous tissue. *Cause.*—It generally comes on suddenly, and often supervenes upon some previous inflammatory condition of the larynx or neighbouring parts. It is of common occurrence after scalds or burns of the throat, stings of insects, or the impaction in the larynx of a foreign body; or it may occur in the course of such diseases as erysipelas, fevers, and small-pox; or be engrafted on tuberculous or syphilitic ulceration of the larynx, perichondritis, or necrosis of the cartilage. Œdema of the larynx of a passive character is also a frequent termination of Bright's disease. The *symptoms* in the acuter forms are most urgent, the dyspnœa is extreme, and if not relieved rapidly ends in spasm and death. When less acute the voice is affected, inspiration is often stridulous and laboured, and swallowing may be painful and difficult—symptoms which may be followed by cyanosis, coma, and death. The *treatment* must be energetic; an emetic should be given at the onset, and leeches, ice, or, if preferred, hot sponges, applied over the thyroid cartilage. These means failing, the œdematous part must be scarified by the laryngeal lancet, or an O'Dwyer's tube, if at hand, passed through the glottis, and retained there until the œdema subsides; otherwise laryngotomy or tracheotomy must be performed.

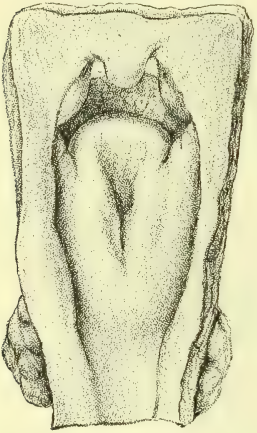


Fig. 286.—Œdematous Laryngitis. (St. Bartholomew's Hospital Museum.)

Membraneous laryngitis, laryngeal diphtheria or laryngeal croup, is a disease of childhood, and may either begin in the larynx, or spread to it from the fauces and pharynx. It is characterized by the formation of a false membrane, which may extend into the trachea and bronchi (Fig. 287). The membrane, which may be hard and tough, or soft and crumbling, and of a yellowish or greyish-white colour, is produced by the coagulation of fibrinous material exuded on the surface of the mucous membrane. It consists of a delicate network of fibres enclosing leucocytes, cast-off epithelium, and granular *débris* in its meshes. The Klebs-Loeffler bacillus is found in the membrane. On its separation the mucous membrane beneath is generally, though not invariably, found to be denuded of epithelium, congested and inflamed; but the mucosa is not usually involved as is the case in diphtheritic inflammation of the fauces and pharynx. This difference would appear to depend on the site of the inflammation and the intensity of the process. The *symptoms*, when the disease begins in the larynx, generally come on very gradually; and at first cannot be distinguished from an ordinary catarrh. Soon, however, and often first during the night, the cough acquires a ringing or brassy character, and soon afterwards, if not simultaneously, the inspiration becomes stridulous, and later the voice "hoarse, cracked, and whispering, or in young children, totally suppressed." Dyspnœa is now marked; the soft parts of the chest-walls recede during inspiration; the inspiration is heaving; expiration as well as inspiration may also become impeded, and the child, if not relieved, rapidly becomes cyanosed and dies. When the disease spreads from the pharynx, the laryngeal signs may at first be masked; but later, they are similar to those given above. *Treatment.*—Internally quinine and perchloride of iron may be given, whilst locally when any membrane is visible on the fauces and pharynx it should be removed, and prevented, if possible, from re-forming by swabbing out the throat at frequent intervals with boro-glyceride, perchloride of iron, lactic acid, carbolic acid, or other disinfectant. The child may be placed under chloroform, if necessary, to ensure the thorough removal of the membrane. Although it is perhaps too early to pronounce an opinion as to the exact value of the subcutaneous injection of diphtheria antitoxin, its efficacy seems undoubted, since a marked

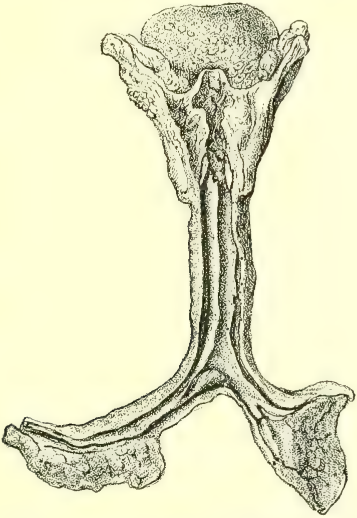


FIG. 287.—Membraneous laryngitis or croup.
(St. Bartholomew's Hospital Museum.)

decrease in the percentage of mortality from diphtheria has resulted in the hospitals where it has been used. It would appear that the earlier the injections are made in the disease the more prospect there is of success since the antitoxin can only neutralize the toxin present in the system, not undo the damage to the muscles and nerves already done, nor control the secondary septic processes which may have been set up. The dose must be sufficiently large and should be regulated more by the severity of the symptoms than by the age of the patient. It must be calculated by immunizing units and not by volume. Less than a thousand such units should never be administered in a single dose, and this should be repeated every two, three, or four hours till all danger is over.

Should the larynx become obstructed, *tracheotomy* must be performed. The chief indications for this operation are—1, retrocession of the soft parts of the chest-walls; 2, suppression of the voice; and especially 3, impeded expiration. Before introducing the tracheotomy-tube the membrane should be thoroughly removed both from the trachea and larynx by a feather or by the suction-tube apparatus, and its re-formation if possible prevented by constant spraying of the part through the tube with an alkaline lotion or lactic acid. The patient's bed should be surrounded with curtains, and the atmosphere kept moist by steam to which an antiseptic is added. He should be fed with soft solid nourishment, and if necessary by a flexible silk tube passed through the nose. Stimulants are generally required. The recumbent posture should be insisted on, as there is grave danger, if the patient attempts to sit up, of sudden and fatal cardiac syncope.

TUBERCLE OF THE LARYNX, also called laryngeal phthisis, may sometimes occur as a primary affection, though it is generally secondary to tubercle of the lung. It is characterized by the formation of miliary tubercles under the mucous membrane, which subsequently break down, leading to ulceration. The *symptoms* are those of ordinary chronic laryngitis, but in addition to these, the patient often presents signs of pulmonary phthisis. On examination the mucous membrane looks pale, and the aryteno-epiglottidean folds swollen and often of a pyriform shape; later, ulceration will be discovered, and may be followed by caries and necrosis of the laryngeal cartilages, dysphagia, and œdema of the glottis. *Treatment.*—The usual constitutional treatment for tuberculous diseases must be employed, combined with guiacol (♏j. in capsules three times a day). Lactic acid (10% to 70%) should be applied to the ulcerated surface, or after first curetting if ulceration has not as yet occurred. The insufflation of morphia and painting the part with cocaine before taking food may be tried to relieve the cough and the difficulty and pain in swallowing. Should swallowing become impossible, the patient should be fed with the œsophageal tube whilst lying face downwards. Tracheotomy must be performed if suffocation threatens.

Syphilis of the larynx.—In the secondary stages of syphilis, catarrhal inflammation, superficial ulceration, and mucous patches may occur; whilst in the tertiary stages characteristic ulcers due to breaking down of gummata are not very uncommon. Tertiary ulceration may extend to the perichondrium, or a gumma may begin beneath that membrane, and in either case lead to necrosis or caries of the cartilages. On the healing of the ulcers contractions and adhesions producing stenosis of the larynx may ensue. General syphilitic *treatment*, appropriate to the stage, should be employed.

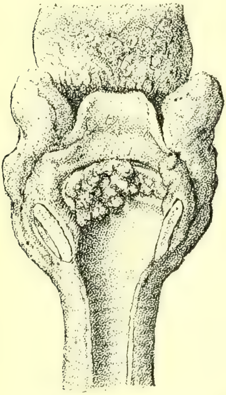


Fig. 288.—Papilloma of larynx. (St. Bartholomew's Hospital Museum, No. 1,648.)

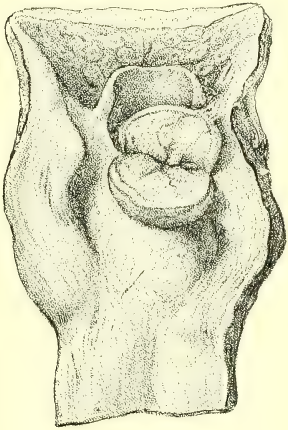


Fig. 289.—Sarcoma of larynx. (St. Bartholomew's Hospital Museum, No. 1,653.)

Scarification or tracheotomy is called for in tertiary affections hould œdema of the glottis supervene. In *stenosis* an attempt may e made to dilate the contracted glottis by means of O'Dwyer's ubes, or the stricture may be divided with a guarded knife, or with he galvano-cautery.

Tumours both innocent and malignant occur in the larynx. Of he former the papillomata and fibromata are the most common, of he latter the epitheliomata. *The papillomata* occur as warty or edunculated excrescences, or as soft, flocculent, villous-like bodies, nd generally grow from the vocal cords and front of the larynx Fig. 288). They may be single or multiple. *The fibromata* are ss common, and occur as small, smooth, solitary, spherical, edunculated or sessile growths, springing from the vocal cords.

The epitheliomata usually grow from the mucous membrane covering the arytenoid cartilages, or from the ventricular bands or cords. A *sarcomatous* tumour growing from the right aryepiglottic fold is shown in the accompanying illustration (Fig. 289).

The chief *symptoms* of a growth in the larynx are hoarseness or aphonia, and dyspnœa. When the growth is pedunculated the symptoms are often paroxysmal and intermittent in character, in consequence of the growth being moved by the current of air in respiration. The laryngoscope is essential for the diagnosis. In the early stages it may be difficult to distinguish an innocent from a malignant tumour, but if a small piece can be removed, a microscopical examination will usually clear up the point. Later, the rapid growth of the tumour, its tendency to ulcerate, its induration, its involvement of surrounding parts, the enlargement of lymphatic glands, and the accompanying pain and cachexia will indicate malignancy. Frequently, however, the lymphatic glands are not involved, and there may be no cachexia.

Treatment.—Innocent growths should be removed if possible by the intra-laryngeal method. This may be done by evulsion with the laryngeal forceps, or by excision with the cutting forceps, or with the cold wire or galvano-cautery snare, local anæsthesia being induced by cocaine or eucaine. When of very large size, or broad-based, or situated below the cords, or in other parts where they cannot be removed by this method, laryngo-tracheotomy or thyrotomy may have to be performed. When a malignant growth is confined entirely to the larynx, and the glands of the neck are not involved, thyrotomy may still be performed, and the growth completely cut and scraped away from the cartilages, or if the cartilages are found invaded, part, or even the whole of the larynx may be extirpated Otherwise palliative treatment only can be employed, or tracheotomy performed if suffocation threatens.

OPERATIONS ON THE AIR PASSAGES.

Under this head are included *tracheotomy*, *laryngotomy*, *laryngo-tracheotomy*, *thyrotomy*, *subhyoid pharyngotomy*, and *intubation* and *extirpation of the larynx*. A. Tracheotomy, laryngotomy, and laryngo-tracheotomy may be required, 1, for establishing a permanent opening below an obstruction of the larynx; 2, as a temporary expedient until such an obstruction can be removed; 3, for the extraction of a foreign body or growth; and 4, to prevent blood entering the trachea during operations about the mouth, jaws, tongue, and pharynx. B. Thyrotomy and subhyoid pharyngotomy may be necessary for the removal of a growth or foreign body when such cannot be extracted by the intralaryngeal method or by one of the former operations. C. Complete or partial extirpation of the larynx may have to be undertaken for a malignant growth confined to the larynx. Before performing any of these operations the surgeon should consider well the anatomy of the middle line of the neck. Beginning at the chin is the raphé between the mylo-hyoid muscles, next the hyoid bone, and then the thyro-hyoid membrane through which an incision is made in the operation of *subhyoid pharyngotomy* (Fig. 290, a). Below this is the pomum Adami, or the notch in the thyroid cartilage which, though prominent in adults, especially in males, can hardly be felt in the fat neck of a child. An incision exactly in the middle line through the thyroid cartilage is known as *thyrotomy* (Fig. 290, b). A little below the thyroid cartilage the cricoid can be felt. It is situated opposite the fifth or sixth cervical vertebra and is an excellent landmark, and it can always be distinguished, however fat the neck. Between it and the thyroid cartilage is the crico-thyroid membrane, which is quite superficial, being covered only by the skin, superficial and deep fascia, and the overlapping sterno-hyoid muscles. This is the spot where *laryngotomy* is performed (Fig. 290, c). Below the cricoid cartilage are two or three rings of the trachea, and then the thyroid isthmus. There is usually a space between the cricoid cartilage and the isthmus of a quarter to half an inch. Here the trachea is

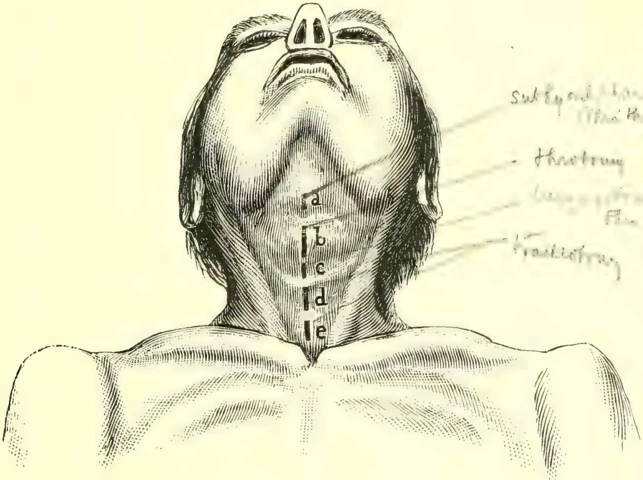


FIG. 290.—Situation of incisions for operations in middle line of neck. **a.** Subhyoid pharyngotomy. b. Thyrotomy. c. Laryngotomy. d. Tracheotomy above isthmus. e. Tracheotomy below isthmus. The lines only show the relative situation of the incisions, not their correct length.

merely covered by the skin, superficial and deep fascia, and the overlapping sterno-hyoid muscles on either side, and it is in this situation that *tracheotomy* is best performed (Fig. 290, d). When the incision is extended upwards through the cricoid as well as through the upper rings of the trachea, it is called *laryngo-tracheotomy.* After the isthmus of the thyroid gland, which, in adults, is usually about half an inch wide, follow four or five rings of the trachea, and then the upper border of the sternum. Below the isthmus the trachea recedes from the surface, and in addition to the skin and superficial and deep fascia, is covered by the sterno-thyroids as well as the sterno-hyoids, and by two layers of deep fascia between which is the large inferior thyroid plexus of veins. Superficial to the muscles, the anastomotic branch between the anterior jugular veins also crosses the trachea. On the trachea itself are several small branches from the inferior thyroid arteries, and sometimes the thyroidea ima, an abnormal branch coming off from the aorta; whilst, rarely, the innominate vein may be higher than usual, and cross the trachea above the level of the sternum. On either side of the trachea, low in the neck, are the carotid arteries. Some surgeons perform tracheotomy below the isthmus (Fig. 290, e); but a review of these anatomical relations makes it evident how much greater is the risk and difficulty then attending it.

TRACHEOTOMY may be performed either above or below the thyroid isthmus. The former situation, should, as a rule, be chosen, as here the operation can be performed with greater ease and less risk. Moreover, there is less danger of suppuration extending between the layers of the cervical fascia which are necessarily opened if the low operation is done. In favour of the low operation, on the other hand, it is argued that the opening is further from the disease when the larnyx is affected, and nearer to the bronchi when a foreign body has to be extracted; and that there is more room than above the isthmus, as the latter sometimes touches the cricoid cartilage. The isthmus, however, can be drawn downwards quite easily with blunt hooks, or, if necessary, may be divided in the middle line with perfect safety and practically no hæmorrhage. If there be any advantage in the low operation in that the trachea is opened further from the disease, it is, in my opinion, fully compensated for by the lesser risk attending the high operation.

The *high operation* only will be here described. It may be done either with or without chloroform. Chloroform should, as a rule, be given to children, as otherwise their struggles are apt to embarrass the operator. In adults, however, it is not necessary, as after the skin-incision has been made no pain is felt, and chloroform is liable to increase the dyspnœa, if present, to a dangerous extent and necessitate the operation being rapidly performed, whereas the more deliberately it can be done, the less is the risk attending it. A small pillow having been placed beneath the neck so as to render it prominent, make an incision from the cricoid cartilage, exactly in the middle line, for an inch and a half to two inches downwards according to the age of the patient, fatness of the neck, &c. (Figs. 290, d, 294, d). Divide the skin and superficial fascia, and having found the interval between the sterno-hyoid muscles continue your incision between them, carefully avoiding any large veins. The isthmus of the thyroid will now be seen in the lower part of the wound as a bluish-red body; and if sufficient room does not exist between it and the cricoid cartilage, draw it down gently with a blunt hook; or if this cannot be readily done, notch it in the middle line or divide it. The drawing downwards of the isthmus is greatly facilitated by dividing transversely on the cricoid the layer of fascia which extends from the cricoid cartilage to the isthmus. By doing this, moreover, the wounding of the veins between the layers of fascia will be avoided. The first two or three rings of the trachea having now been fully exposed, and all arterial hæmorrhage arrested by ligature or pressure-forceps, thrust the sharp hook into the trachea immediately below the cricoid cartilage, and, steadying it in this way, divide the first two or three rings by thrusting in the knife with the back of the blade directed downwards and by cutting towards the cricoid. Venous hæmorrhage, except from a large vein, which of course should be tied or clamped, need not delay the opening of the trachea, as it depends on engorgement of the right side of the heart, and will disappear after two or three inspirations through the tracheal wound. The wound in the trachea being held open by the tracheal dilator, pass the outer tube, made wedge-shaped by pressing it between the finger and thumb, into the trachea, and then immediately insert the inner cannula, as until this is done, air cannot freely pass through the tube. Secure the tube *in situ* by tracheotomy tapes tied behind the neck. Where the operation is performed for croup or diphtheria, the tube should not, as a rule, be inserted at once, but the wound held open by the dilator, and any false membrane removed by a feather passed both down into the trachea and up into the larynx, or if this does not succeed, by a Parker's suction-tube apparatus. The bivalve cannula in general use is apt, on account of its shape, to produce ulceration of the anterior wall of the trachea, on which from its curve it must necessarily impinge; it has even been known to perforate the wall and to enter the innominate artery. This can be prevented by the improved shape of the cannula invented by Mr. R. W. Parker (Fig. 291). Should the breathing cease during the operation,

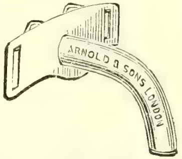


Fig. 291.—Parker's cannula.

the trachea should still be opened, the obstructing membranes removed, and artificial respiration persevered in for some time.

Dangers and difficulties of the operation.—Where the operation can be done deliberately, and on a patient with a thin neck, it is attended with no great difficulty; but where, as is frequently the case, it has to be undertaken on an emergency, possibly with insufficient light and with no skilled assistant at hand, or on a young child or infant with a fat neck, and has to be completed rapidly to prevent death from suffocation, it is perhaps one of the most trying that the surgeon is called upon to perform. The dangers into which the inexperienced and unwary may then fall are the following:—

1. *The hyoid bone or the thyroid cartilage* may be mistaken for the cricoid cartilage, and the incision made through the thyro-hyoid membrane or into the thyroid cartilage. This mistake could hardly occur except in a fat-necked child, and then only through carelessness in not determining the position of the cricoid cartilage before beginning the operation.

2. *The interval between the sterno-hyoid muscle may be missed*, and the dissection carried to one or other side of the trachea. The thyroid body and even the carotid artery has in this way been wounded. To avoid such a disaster the head should be held perfectly straight and the incision made accurately in the middle line; one side of the wound should not be retracted more than the other; and the index finger should be used from time to time to make sure that the dissection is being made over the trachea.

3. *Too short an incision may be made*, and consequently be a source of embarrassment in drawing down the thyroid isthmus, and in defining the trachea before it is opened. The incision should never be less than an inch and a half long even in a child.

4. *One or more large veins may be wounded*, and the steps of the operation be considerably impeded by hæmorrhage. Their walls are very thin; great care therefore is necessary to avoid injuring them.

5. *The knife may perforate the posterior wall of the trachea* and enter the œsophagus. Caution, therefore, is necessary, and some advise that the knife should be held, whilst incising the trachea, with the forefinger placed on one side half an inch from its point, so that it cannot penetrate too deeply.

6. *The knife may slip to one side*, instead of entering the trachea. This can hardly happen if the trachea is fixed by the sharp hook and drawn well forward into the wound whilst being perforated.

7. *The innominate vein and even the innominate artery have been wounded* in incising the trachea during the performance of the low operation. The knife, therefore, should be introduced with the back of the blade towards the sternum, and the incision made from below upwards.

8. *Blood may enter the trachea*, and if allowed to remain there will coagulate, and the clots, being drawn into the bronchi and acting as plugs, may cause suffocation. This danger should be guarded against by tying all bleeding vessels, and thoroughly exposing the trachea before incising it, lest there should be a vessel in front of it. Should only a little blood enter the trachea, it can be coughed up; but if the amount is large, the patient should be turned on his side, and the head depressed, the wound of course being held open by retractors, to allow it to run out; or if this does not suffice, an attempt must be made to remove it by suction. When there is a general oozing of blood from the wound, the introduction of the tube will prevent more escaping into the trachea.

9. *The tracheotomy tube may be forced between the fascia and the front wall of the trachea; or one valve of the tube may be passed inside the trachea, and the other outside.*—To escape these accidents, the incision in the trachea should be free, and its edges well retracted, or one edge may be held up by a sharp hook. To ensure both valves entering the trachea, they should be pressed well together; this may be conveniently done by Sankey's forceps (Fig. 292).

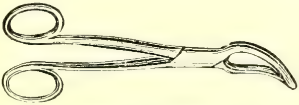


FIG. 292.—Sankey's forceps for introducing tracheotomy tube.

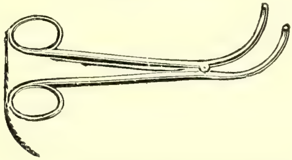


FIG. 293.—Author's pilot for Mr. Morrant Baker's soft tube.

10. *The tube, where membrane is present, may be passed between the tracheal wall and the false membrane*, a danger that may be guarded against by removing the membrane before introducing the tube.

11. *The tube has been passed upwards into the larynx instead of downwards into the trachea.*—No excuse, and it is to be feared no remedy, could be found for such gross ignorance.

After-treatment.—The room should be kept at a uniform temperature, the air rendered moist by means of a steam-spray apparatus, and the bed well surrounded with curtains. The inner tube, especially if the operation is performed for diphtheria or croup, should be freed at frequent intervals with a feather, or with a small sponge fixed on a wire, and well cleansed by the nurse at least two or three times a day. The outer tube, which also requires cleansing once a day, should only be removed by the surgeon himself. Where it is necessary that a tube should be worn for any length of time, Mr. Morrant Baker's india-rubber cannula should be substituted for a silver tube. I have employed this immediately after the operation, but it is perhaps safer not to do so until the wound has been dilated for a few days by the silver cannula, as, at first, the resiliency of the tracheal rings tends to close the wound, and the india-rubber has been found in some instances not sufficiently stiff to resist their pressure. The pilot shown in Fig. 293, inasmuch as it renders the end of the tube stiff and wedge-shaped, facilitates its introduction. The india-rubber tubes may be worn with the greatest comfort, and for prolonged periods. I have now a patient who has worn them for upwards of five and a half years. When lined with canvas, as suggested by Mr. Baker, the tube will last in very good condition for nearly twelve months. If a silver tube be worn it should be examined on each removal, any blackening of the end, and, of course, the presence of blood, being an indication that ulceration is in progress. The tube should only be worn as long as respiration through the glottis is impeded. To determine when it may be dispensed with it is merely necessary to close the wound with the finger and thus test the breathing. As a rule, it is better to remove it at first only during the day, or for a few hours at a time, or where a fenestrated cannula is used the external opening may be stopped, for certain periods, with a plug to gradually accustom the patient to breathe through the glottis. When the tube has been worn for any length of time some difficulty is often experienced in leaving it off. This may depend chiefly on: 1, the formation of granulations in the trachea above the opening for the tube; 2, adhesions of the vocal cords to one another; and 3, paralysis complete or partial of the intrinsic muscles of the larynx. Where granulations are the cause of the obstruction, they should be touched at intervals with nitrate of silver. Where there is adhesion of the vocal cords the glottis may either be dilated by O'Dwyer's tubes, or the adhesions broken down by probes passed up through the wound or down through the mouth. The power of the muscles may be restored by galvanism, one pole being placed in the larynx, and the other over the situation of the recurrent laryngeal nerve. In children the condition improves as they grow older and as the larynx becomes more developed.

LARYNGOTOMY.—Feel for the cricoid cartilage, and if the case is urgent, and the patient evidently *in extremis*, plunge a penknife through the skin and subjacent crico-thyroid membrane transversely, immediately above the cricoid cartilage, and hold the wound open by a hair-pin, piece of wire from a champagne bottle, &c. When the operation can be done deliberately, make an incision exactly in the middle line of the neck from a little above the lower border of the thyroid cartilage to a little below the upper border of the cricoid cartilage (Figs. 290 and 294, c), and the crico-thyroid membrane having been thus exposed, incise it transversely, introducing the knife immediately above the cricoid cartilage, so as to be as far as possible from the vocal cords, and in order to avoid wounding the little crico-thyroid artery which anastomoses with its fellow usually across the upper part of the space. This artery, though commonly so insignificant that any hæmorrhage from it could be readily controlled by the tube, is sometimes of considerable size, and, if then wounded, would require tying. The laryngotomy tube should be somewhat compressed from above downwards, so as better to correspond with the shape of the crico-thyroid space. Some surgeons recommend that the incision through the crico-thyroid membrane should be vertical as the anterior jugular veins and the crico-thyroid muscles have been injured in making the transverse incision, and an aërial fistula has at times remained after the latter has been employed. Further the vertical incision has this advantage, that it can be prolonged downwards through the cricoid cartilage if more room is required.

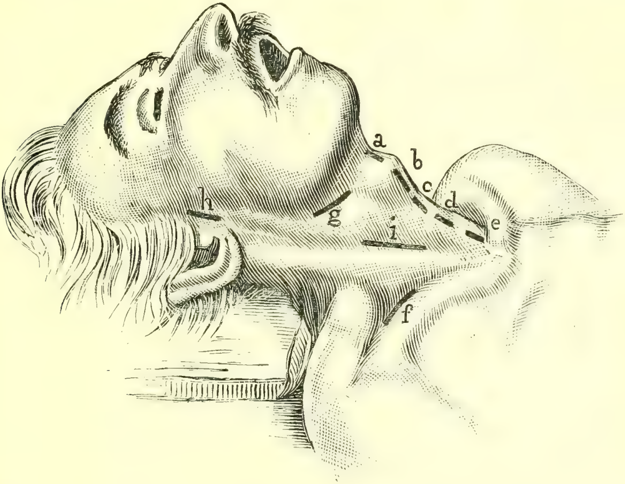


FIG. 294.—Incisions in certain operations on the neck. *a*. Subhyoid pharyngotomy. *b*. Thyrotomy. *c*. Laryngotomy. *d*. Tracheotomy above, and *e* below, the isthmus of thyroid. *f*. Ligature of subclavian (3rd part). *g*. Ligature of lingual. *h*. Ligature of temporal. *i*. Ligature of common carotid.

LARYNGO-TRACHEOTOMY consists in prolonging the incision in the trachea through the cricoid cartilage. It is sometimes done when there is not room between the cricoid cartilage and the isthmus for the performance of tracheotomy ; also for the purpose of removing a growth from the larynx. Although no harm may follow the division of the cricoid, it should be avoided, if possible, as the integrity of the larynx is thereby interfered with, and serious impairment of the vocal apparatus has occasionally been the result.

Comparison of the operations of tracheotomy and laryngotomy.—Laryngotomy is a much easier operation and can be done with greater rapidity than tracheotomy. For this reason it is *par excellence* the one to be undertaken on an emergency, as, for instance, threatened suffocation from the impaction of a portion of food at the entrance of the larynx. In children tracheotomy, or, in the case of an emergency, laryngo-tracheotomy, should always be undertaken, as the crico-thyroid space in them is too small to admit a tube. In adults, when either laryngotomy or tracheotomy can be performed deliberately, the opinions of surgeons are somewhat at variance as to which operation ought to be undertaken for the varying conditions calling for an opening into the air-passages below the glottis. For my own part, I always do tracheotomy (except in cases of emergency), as this operation does not interfere with the integrity of the larynx; whereas after laryngotomy the voice has at times been lost or impaired owing to contraction of the crico-thyroid membrane, or to inflammation of the crico-thyroid joint or crico-arytenoid joint. Further, there is often difficulty with the tube.

THYROTOMY, or laying open the larynx from the front by dividing the thyroid cartilage in the middle line, may be required for the removal of a tumour or a foreign body impacted in the larynx after a thorough and careful attempt has been made to extract it by the natural passages (*intralaryngeal method*). Make an incision accurately in the middle line of the neck from the hyoid bone to the cricoid cartilage (Figs. 290, b, and 294, b), and, having exposed the thyroid cartilage, and stopped all bleeding, divide it along the angle formed by the junction of the alæ, taking care to do so in the middle line so as not to injure the vocal cords. Separate the alæ, paint the parts with cocaine (10% to 20%) to allay cough and reflex vomiting, and remove the growth, &c., and bring the alæ accurately together again, and unite them by silver wire or kangaroo-tail-tendon sutures, which should not, however, be passed through the whole thickness of the cartilage. When the removal of the growth is likely to be attended with hæmorrhage, tracheotomy should first be performed and the trachea plugged by Hahn's cannula. The head should be kept low and on one side after the operation, and the tube removed if possible at once or within twenty-four hours.

SUBHYOID PHARYNGOTOMY consists in opening the pharynx through the thyro-hyoid membrane (Figs. 290, a, and 294, a), for the purpose of removing a tumour or impacted foreign body at the entrance or in the upper part of the larynx. It is so rarely required that the steps of the operation are not given in detail.

INTUBATION OF THE LARYNX consists in passing a properly-shaped tube through the glottis by means of a forceps or pilot invented for the purpose. The tubes now used are those known as O'Dwyer's. Intubation is employed as a substitute for laryngotomy or tracheotomy in certain cases, as œdematous laryngitis, membraneous laryngitis, &c. It does not seem likely that intubation, as has been maintained by some, will replace tracheotomy for membraneous laryngitis, since there is a danger of the membranes being forced into the trachea by the tube, thus causing obstruction, nor does the intubation admit of the removal of the membranes as can be done after tracheotomy. In œdematous laryngitis, however, it is a very useful procedure.

LARYNGECTOMY OR EXTIRPATION OF THE LARYNX.—Partial or complete removal of the cartilages of the larynx may be required for malignant disease when the growth is confined to that organ and the glands in the neck are not involved. First perform tracheotomy, and plug the trachea with Hahn's tampon cannula, and continue the administration of the anæsthetic through it. Next make an incision in the middle line of the neck from the hyoid bone to the tracheotomy wound, with a transverse cut at each end if more room is required; free the upper part of the trachea and the larynx from their attachments by dissecting close to these structures, securing all bleeding vessels as they are divided. Divide the trachea above the cannula and detach the larynx from the remaining connections, working from below upwards. Where part of the larynx can be saved, the risks of the operation will be greatly lessened. Lightly plug the wound with aseptic gauze, leaving the cannula *in situ* for twenty-four hours. The patient should lie with his head low and on one side, and should be fed at first through a soft tube passed down the œsophagus, and by nutrient enemata. On the healing of the wound an artificial larynx, if the whole organ has been removed, may be fitted to the parts, by the help of which the patient will be able to speak moderately distinctly.

DISEASES OF THE PAROTID GLAND.

PAROTITIS, OR MUMPS, is an acute infectious disease attended with sharp febrile disturbance, and with a local inflammation of the parotid gland. There is generally much pain and swelling, but neither redness nor tendency to suppuration. On the subsidence of the inflammation in the one gland, the opposite, if not already affected, generally becomes inflamed, or more rarely the testicle, ovary, or mamma is attacked—a condition spoken of as metastasis. Confinement to the house, a gentle laxative, and a belladonna or opiate liniment or poppy fomentations to soothe the pain is all that is usually required.

Parotitis may follow surgical operations, especially those involving the abdominal cavity. It soon subsides if the original wound runs an aseptic course, but if it be due to septic absorption, suppuration, as a rule, quickly ensues (*pyæmia*).

PAROTID ABSCESSES should be opened by an incision in front of the posterior border of the jaw to avoid the external carotid artery, and parallel to the facial nerve.

PAROTID TUMOURS may begin in the parotid gland itself, or, as is perhaps more often the case, in one of the lymphatic glands situated over it. They have a great tendency to displace or destroy the parotid, and to extend deeply amongst the important structures behind the ramus of the jaw, where they may surround the carotid arteries, or even encroach upon the pharynx. In structure they may be fibrous, myxomatous, cartilaginous, sarcomatous or carcinomatous. The tumour, however, most common in the parotid region consists of cartilage intermixed with fibrous tissue, with atrophied glandular elements, and often with mucous tissue. The cartilage which so frequently exists in parotid tumours is believed to be derived from the elements of the rudimentary fœtal structure concerned in the development of the lower jaw, and known as Meckel's cartilage. Cysts are very rare, but cystic degeneration of the solid tumours is not infrequent.

Symptoms and diagnosis.—The differential diagnosis of the various parotid tumours cannot be here attempted. Nor is it of consequence, as it is often impossible before removal to determine their exact nature. The practical points for the surgeon to consider are:—Is the growth innocent or malignant? Can it be safely removed? *Innocent tumours* grow slowly, and are at first freely moveable, smooth or slightly lobulated, circumscribed, hard and firm or semi-elastic; but as they increase in size they may become soft or fluctuating in places, either from mucoid softening or cystic degeneration. The skin over them, though stretched and thinned, is non-adherent, and the glands are not affected. *Malignant tumours*, on the other hand, grow rapidly, are ill-defined in outline, generally soft or semi-fluctuating, and become firmly fixed to the surrounding parts; the skin is adherent, purplish-red, brawny, infiltrated with the growth, and later ulcerated; and the lymphatic glands are enlarged. An innocent tumour, however, after having grown slowly for many years may suddenly take on rapid growth and malignant characters.

Treatment.—When the tumour appears innocent, of moderate size and freely moveable, indicating that its attachments are not deep, there can be no question about its excision. But when of very large size, especially if firmly fixed to surrounding parts, or if malignant, unless quite small and the skin and glands are not to any extent involved, it should be left alone. *The Operation.*—Make a free longitudinal incision through the skin and fascia to thoroughly expose the tumour; it will then often readily shell out of its capsule. If not draw it forward with vulsellum forceps, and separate its deeper attachments with the handle of the scalpel and occasional touches of the knife, the edge of which should be turned towards the tumour to avoid the branches of the facial nerve and other important structures. The proximity of the carotids should not be forgotten.

DISEASES OF THE THYROID GLAND.

BRONCHOCELE, GOÎTRE OR DERBYSHIRE NECK is an enlargement of the thyroid gland. It may be due, as is commonly the case, to simple hypertrophy of the normal tissues of the organ (*ordinary goître*), and may then involve the whole gland or one of the lateral lobes, or rarely only the isthmus. In other instances, the hypertrophy may fall chiefly on the fibrous tissue constituting the septa of the gland (*fibrous goître*). Or along with some amount of simple hypertrophy and increase of fibrous tissue (*adenoma*), one or more of the normal alveolar spaces may become enlarged, forming single or multiple cysts (*cystic goître*). Such cysts contain when single a serous fluid, or when multiple a colloid or a dark grumous material sometimes mixed with altered blood; whilst occasionally proliferating growths project into their interior from the cyst-walls. In other instances, again, but more rarely, the hypertrophy is associated with a great increase in the vessels, and a forcible and expansile pulsation is given to the gland (*pulsating goître*). But the tissues, besides hypertrophy, may undergo secondary changes. Thus calcification may occur, and the enlarged gland become, in places, of stony hardness (*calcified goître*), or the fluid normally contained in the alveolar cavities may assume a colloid character. Lastly, the enlargement of the thyroid may be due to malignant disease (*malignant goître*). Goître in certain districts is endemic, especially in the Rhone Valley in Switzerland, and in Derbyshire, and is then frequently associated with the condition known as cretinism. It also occurs sporadically; and in some cases again is accompanied by a peculiar jerking beat in the carotids, anæmia, and a prominence of the eyeballs (*exophthalmic goître*), for a full account of which a work on Medicine must be consulted.

The *Symptoms* common to any form of enlargement of the thyroid is a swelling taking more or less the characteristic shape of the thyroid gland, and moving with the larynx in deglutition. In this country the enlargement is generally moderate; but sometimes, and especially in Switzerland, the goître forms a large mass hanging down in front of the neck, and may press upon, or even displace, the trachea or œsophagus. It occurs chiefly in women. In the ordinary variety it feels soft, semi-fluctuating, and of uniform consistency; in the cystic, one or more fluctuating places may be felt; whilst in the fibrous it will be firm and hard and more or less lobed or irregular, and where calcification has taken place, of stony hardness. Malignant goître, which is very rare, may be known by rapid growth, enlarged glands, and the other signs of malignancy mentioned at page 65.

The *Cause* of endemic goître is not known. It has been attributed to impure water, water from limestone, and snow water, but without conclusive evidence. It is said to be most prevalent in valleys where, from their direction, the sun does not penetrate, on damp soil, and in damp parts of towns, but according to Mr. Berry these influences have little or nothing to do with its causation. In sporadic cases, heredity, disturbance of the sexual functions, and conditions producing congestion of the head and neck, are given as causes. Recently it has been shown that the active principle in the thyroid secretion is an albuminous compound containing iodine (*thyro-iodine*), and it is suggested that the cause of goître may be the absence of iodine in the system and the compensating hypertrophy of the gland.

Treatment.—Sporadic cases of ordinary goître have hitherto been generally treated by the internal and external application of iodine. Thus the syrup of the iodide of iron may be given internally and an ointment of iodine and iodide of potassium applied externally. The use of biniodide of mercury ointment, followed by exposure to a hot sun, has been much praised in India. An ice collar has sometimes been of service. Recently considerable success has attended the administration of thyroid extract. Under its influence ordinary goîtres in young subjects are diminished in size, and the gland tissue about cysts and adenomata atrophies so that they can be more easily shelled out. Fibrous goîtres are uninfluenced. The improvement is, as a rule, only temporary. Should an operation subsequently become necessary the bleeding is said to be less, but there is a greater tendency to heart failure. Injection of iodine or of perchloride of iron into the solid parts of the growth is highly dangerous, sudden death having occurred either from the accidental entrance of air or injection of the iron or iodine into a vein. In *cystic* and *adenomatous goître* the cyst or tumour can, as a rule, be readily shelled out from the rest of the gland. Where great dyspnœa has threatened suffocation, the whole gland has been removed;

but since it has been shown that such removal is productive of myxœdema or a condition like it (*strumapriva*), it is a question whether complete removal is ever justifiable. It is better to divide the isthmus in the middle line for the purpose of freeing the trachea (which is compressed laterally, not from before backwards) or to remove the isthmus or one lobe of the gland, when the rest will generally shrink. If necessary to remove both lateral lobes the lower end of each should be left, namely, that part into which the inferior thyroid artery enters. The recurrent nerves are not then endangered (*Mikulicz's operation*). In removing either lateral lobe of the gland it should be borne in mind that, although the common carotid artery is pushed outwards, the internal jugular vein usually runs over the tumour, being held more or less in position by the veins opening into it. The pulsation of the artery is, therefore, no guide to the position of the vein, which may run in front of, or internal to the artery. Care should also be taken not to open the thin capsule of fascia surrounding the gland either in front or at the outer side in order to avoid wounding the large and thin-walled veins which lie beneath it. Behind, where this capsule is reflected on to the larynx and trachea, it must necessarily be divided. At this spot the veins should be tied. In all operations for goître as little anæsthetic as possible should be used. *Endemic goître* admits of little treatment other than removal of the patient from the goîtrous district. *Malignant goître* except when it involves only a portion of the gland is not amenable to treatment. The propriety of partial extirpation of the thyroid for *exophthalmic goître* is still an open question, as is also the division of the cervical sympathetic chain and *exothyropexy* or the stripping off of the capsule of the gland and suturing the latter in the external wound, where it may undergo atrophy from exposure to the air and from the thrombosis of its veins (*Jaboulay's operations*). For the general treatment of this disease a work on Medicine must be consulted.

Acute goître.—Goître, though usually chronic, sometimes occurs in an acute form, the gland increasing to the size of an orange in a few days, and causing severe, or it may be fatal, dyspnœa, from pressure on the trachea in consequence of the enlargement taking place so rapidly that the fascia of the neck has not time to yield. It occurs in young subjects both sporadically and endemically. In these instances it sometimes makes its way behind the sternum, so that it is difficult to get below it, even if tracheotomy is performed. The cause of the dyspnœa may not be very evident before the operation. *Treatment.*—The pressure may sometimes be removed by simply incising the fascia of the neck. Or tracheotomy may be done, and a long tube passed down the trachea beyond the obstruction; or the isthmus, or one lobe, may be excised. The patient, in the meanwhile, should be removed from the goîtrous district.

DISEASES OF THE SPINE.

SCOLIOSIS OR LATERAL CURVATURE is a complicated distortion in which the spine forms two or more lateral curves with their convexities in opposite directions, whilst the vertebræ involved in the curves are rotated on their vertical axes so that the spinous processes are directed towards the concavity of the curves.

Cause.—The immediate cause that underlies the formation of lateral curvature is the *unequal compression of the intervertebral cartilages for long periods.* This unequal compression may be induced by 1, any condition causing permanent or habitual obliquity of the pelvis and the consequent throwing of the spine over to the opposite side; such as unequal length of the legs, knock-knee, flat-foot, the use of a wooden leg, habit of standing on one leg, sitting cross-legged, congenital dislocation of the hip, &c.; 2, a one-sided position of the body in sitting, standing, or lying, or produced by certain employments, as nursing or carrying with one arm, &c.; 3, contraction of one side of the chest following empyema; 4, unilateral contraction of the spinal muscles following paralysis of the opposing muscles. The conditions mentioned under 1 and 2 are, however, by far the most frequent causes of the deformity. Although lateral curvature may be induced by those causes acting alone, there are certain circumstances that appear especially to predispose to the deformity, by producing a general want of tone in the muscles, structural weakness of the ligaments, and a softened condition of the bones. Such are, 1, heredity; 2, general debility; 3, rickets; and 4, rapid growth. It is much more frequently met with in girls than in boys, and is most common from about the age of fourteen to eighteen.

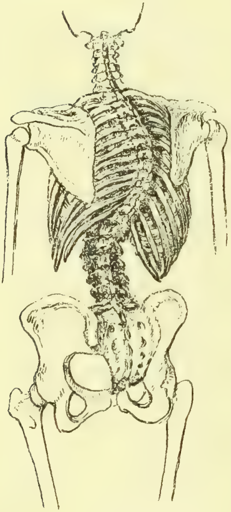


FIG. 295.—Lateral curvature of the spine. (St. Bartholomew's Hospital Museum, No. 1,116.)

Pathology.—The long-continued unequal compression of the intervertebral cartilages causes them to become wedge-shaped, and the portion of the spine corresponding to the compressed cartilages to assume sooner or later a permanent lateral curve. Whilst, however, a curve is thus being produced, say, in the dorsal region with its convexity to the right, a compensating curve in order to maintain the equilibrium of the spine is being simultaneously produced in the lumbar region with its convexity to the left (Fig. 295). Coincidently with these changes a rotary movement of the affected vertebræ upon their vertical axes is taking place, so that while the bodies turn towards the convexity of the curve, the apices of the spinous processes turn towards the concavity. Hence, in addition to the formation of the primary and the secondary or compensating curves, we have a twisting round of the spine within these curves, as a consequence of which the ribs on the convex side are carried backwards with the transverse processes, causing the angle of the scapula on that side to project; whilst the ribs on the concave side are for the same reason carried forwards, producing a prominence of the corresponding breast (Fig. 296). The cause of the rotation has been variously explained. The theory, perhaps, most generally accepted is that of Dr. Judson, who believes that the rotation is due to the fact that the posterior portion of the vertebral column, being a part of the dorsal parietes of the chest and abdomen, is confined by the ligaments and muscles to the median plane of the trunk; whilst the anterior portion projecting into the thoracic and abdominal cavities, being devoid of lateral attachments, is free to move either to the right or left of the median plane when the spine is inclined to either side. At first the bones are not affected, but when the compression of the cartilages has become permanent the bodies of the vertebræ also gradually assume a wedge shape, whilst the articular processes become contracted and flattened on the concave side and elongated on the convex. The ligaments and muscles on the concave side are shortened and atrophied, whilst on the convex side the ligaments are stretched and the muscles become hypertrophied.

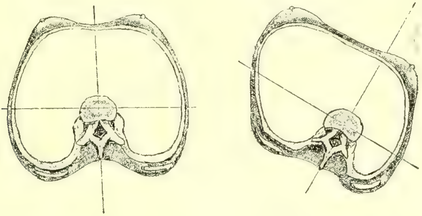


FIG. 296.—To show the effect of rotation in lateral curvature of the spine.

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Signs.—Pain or a feeling of weakness in the back, general lassitude, and a stooping gait, are amongst the early symptoms; but the patient is generally first brought for consultation on account of a slight projection of the scapula, or an apparent prominence of the iliac crest—a growing out of the shoulder or of the hip, as it is popularly termed. In slight cases there may be little or no lateral deviation of the apices of the spinous processes, and the little there is may be made to disappear on suspending the patient or placing her in the prone position. In the severer cases, however, the signs are unmistakable. Thus, in the more common forms, there is usually a dorsal curve with its convexity to the right, and a shorter lumbar, or dorso-lumbar curve, with its convexity to the left. The right shoulder is generally elevated, and the angle of the right scapula, right iliac crest and left breast are prominent, whilst the left lumbar muscles, in consequence of the backward projection of the left lumbar transverse processes, stand out as a prominent ridge and give a greater sense of resistance on pressing over them than normal. In other cases the compensating curves may be so slight that there is apparently a single curve only, with its convexity either to the right or left, involving the whole spine or chiefly the upper dorsal or the lumbar vertebræ, and producing more or less projection of the scapula or apparent prominence of the iliac crest, &c., according to its severity and situation.

Treatment.—Where there is evidence of general or muscular debility the health and muscular tone should be improved by suitable remedies, the avoidance of late hours, fatigue and the like; whilst the exciting cause of the curvature should be looked for and if possible removed. In slight cases, the above means, when conjoined with a judicious selection of muscular exercises and partial recumbency, will generally serve to cure or improve the curvature, or at least prevent it from getting worse. But in severe cases, when osseous changes are already confirmed, some form of rigid support, as a poro-plastic jacket, or a light spinal instrument, will commonly be required, especially for the poorer classes of patients. In ordering such supports, however, the patient should be made to thoroughly understand that no real improvement of the curvature must be expected from them, their only aim being to relieve pain when present, to give a sense of comfort and support, to improve the outward appearance, and to prevent further deformity. In slight cases they should on no account be used. The exercises that I employ are directed in part to improving the muscular tone generally, and in part to strengthening those muscles in particular that tend to lessen or straighten the curves. For the former purpose, such exercises as swinging by the hands from a bar, forcibly stretching an elastic cord fixed to the floor, and dumb-bell exercises, should be practised. For strengthening the muscles in particular that tend to straighten the curve, the back should be manipulated till that posture is found in which the curves are least marked, and the patient made to hold herself in this position for as long as possible. At first she will be only able to do this for a few minutes at a time; but by frequently assuming the posture, the muscles thus brought into play are gradually strengthened till at last the improved posture is maintained constantly and without effort. For further improving the tone of these muscles Professor Busch and Mr. Roth recommend some such exercises as the following:—The patient's body held in the improved posture is brought over the end of a couch or table, and whilst she is prevented from falling by an assistant holding her legs, she alternately flexes and extends her body at the hips, the surgeon resisting her efforts. I have also found the use of the sloping seat, as recommended by M. Bouvier and Mr. Barwell, of considerable service in counteracting the curves. A similar effect may be obtained by wearing a thick sole on one boot, and by sitting on the off-side of the horse when riding. After the exercises, or twice or thrice during the day, the patient should lie on her back for half an hour to an hour, and whilst sitting her back should be supported by a reclining chair. I have had very considerable success in removing rigidity in cases where there is slight osseous deformity by applying a weight to the convexity of the curve, the patient standing with her legs straight and body horizontal and supported in this position by her elbows on a chair.

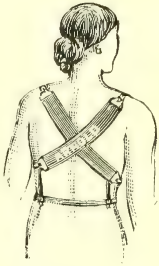

Fig. 297. — Author's spinal brace.

KYPHOSIS is a general curving of the spine with its convexity backwards, or an exaggerated condition of the normal dorsal curve. It depends upon an unequal compression of the intervertebral cartilages and, to a less extent, of the vertebral bodies which thus become wedge-shaped with their bases looking posteriorly. It is generally the result of muscular debility, rickets, slouching habits, or occupations necessitating stooping. The point of chief interest is to distinguish it from the serious angular curvature induced by caries. In children, and in adults, this is generally easy; but in rickety infants, in whom the ordinary tests for caries (see p. 598) cannot be applied, it is often very difficult. In such a case, the infant should be laid across the nurse's knees and gently extended, when the rickety curve will disappear, but the angular will remain. The back, moreover, in caries, is rigid, and the child is uneasy in this position and tries to resist the extension by muscular effort, and draws up his legs. In rickets the back is flexible and there are other signs of rickets. *Treatment.*—In the infant, recumbency; in growing lads and girls the correction of stooping habits by the use of muscular exercises and a spinal brace (Fig. 297), with partial recumbency and tonics, is the treatment usually indicated. For the confirmed kyphosis of the old, nothing can be done.

LORDOSIS, or curving of the spine with the convexity forwards, is a symptom rather than a disease, inasmuch as it is formed as a compensatory curve to restore the equilibrium of the spine when from any cause its normal antero-posterior curves are disturbed. Thus it is most common in the lumbar region, where it is merely an exaggeration of the normal curve; and is there produced to counterbalance the tilting forward of the pelvis consequent upon hip-disease, congenital dislocation of the hips, rickets, &c.

CARIES OF THE SPINE, also called Pott's disease after the surgeon who first accurately described it, is characterized by the destruction of one or more of the bodies of the vertebræ or intervertebral cartilages, and in consequence of this destruction is too frequently attended by the falling forward of the vertebræ above the seat of disease, and the production of angular deformity of the spine. Hence it is often spoken of as *angular curvature.* The curve, however, is only a symptom, and a comparatively late one, of the disease, and ought not to be allowed to form.

Causes.—The disease generally occurs in strumous children, and is then believed, like fungating caries in the articular ends of bone, to be due either to a low form of inflammation set up by a slight injury, or to a deposit of tubercle dependent upon the introduction of tubercle bacilli into the circulation in the manner already mentioned in the section on *Tubercle.* It sometimes occurs in adults who are otherwise perfectly healthy, and can then generally be traced to some injury of the back—probably a strain of the intervertebral cartilages.

Pathology.—The disease most frequently begins in the bodies of the vertebræ, less frequently in the intervertebral cartilages; but in either case both structures soon become involved. In the bodies it generally starts as a rarefying osteitis in the actively-growing layer of bone which exists under the epiphysial cartilages and periosteum. The inflammatory changes that ensue are similar to those already described in rarefying osteitis of cancellous bone. The red gelatinous inflammatory material or granulation-tissue invades both the body of the vertebra and the intervertebral cartilages, and may then attack the vertebræ above and below. Not infrequently several of the vertebræ are affected independently by the disease at the same time. In this granulation-tissue non-vascular areas, presenting the appearance of the tubercle nodules already described, have been found, and tubercle bacilli have in some cases been demonstrated in them. At this stage the disease may cease, the granulation-tissue become converted into bone, and no angular deformity result. More commonly, however, the granulation-tissue, having destroyed the bone-trabeculæ, undergoes caseation, and breaks down into pus, producing a *spinal abscess*; or it may be absorbed without the formation of any pus (*dry caries*);

or if the process has been very acute, large portions of the cancellous tissue may die *en masse*, forming sequestra, which may keep up the morbid process for years (*caries necrotica*). In any of these cases angular deformity will be the result, as partly by its own weight, and partly by the dragging of the abdominal muscles, the upper portion of the spine thus undermined falls forward, and necessarily forms an angle with the lower portion at the seat of the disease. In consequence of the patient's efforts to hold himself upright the normal lumbar and cervical curves, when the disease occurs in the dorsal region, will be greatly increased; the angular projection is thus thrown backwards (Fig. 298), and the well-known hump-back produced. When the disease occurs in the lower lumbar region there is no means of restoring the balance, and the patient is compelled to stand or walk with the body inclining forwards, and, in severe cases, nearly at a right angle with the pelvis. When the disease begins in the intervertebral fibro-cartilages, it probably starts as a low form of destructive inflammation consequent upon a slight laceration or other injury of the cartilage. But however it begins it soon involves the adjacent bones, destroying them along with the cartilage and leading to the angular deformity. The spinal canal, situated as it is in the posterior segment of the column, with the exception of being bent, undergoes but little alteration of its calibre, and the cord, as the bending of the canal occurs but slowly, usually escapes injury. When the disease is acute and the bending consequently more rapid, some amount of temporary paralysis may occur, impairment or loss of motion being far more frequent than loss of sensation on account of the proximity of the anterior or motor columns to the diseased vertebral bodies. The cord is occasionally pressed upon by portions of bone separated from the vertebræ, or by pus making its way into the canal, or by inflammatory thickening of the membranes (*pachymeningitis*). It may sometimes undergo softening, leading to permanent paraplegia.

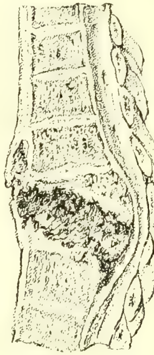
FIG. 298.—Caries of the spine. (St. Bartholomew's Hospital Museum.)

Spinal abscess (*psoas and lumbar*).—When suppuration occurs, the pus collects in front of the diseased vertebræ in the angle formed by the falling forward of the upper upon the lower portion of the spine. The anterior common ligament and periosteum, relaxed by the bending of the spine, yield to the pressure of the pus, and with the pleura or peritoneum become thickened and form the abscess wall. The pus, prevented from travelling upwards by the overhanging vertebræ, downwards in front of the column by the attachments of the anterior common ligament, and backwards by the posterior common ligament, and by the vertebræ being less diseased behind than in front, makes its way on one or other side of the column. There it either enters the sheath of the psoas, and, destroying the contained muscle, presents in the iliac fossa or groin as an iliac or a psoas abscess, or passes backwards through or external to the quadratus lumborum, and points in the loin where it is known as a lumbar abscess. In rare instances the pus may take a different course. Thus I have seen it make its way into the ischio-rectal fossa, or pass through the great sciatic foramen, or travel along the course of a rib and reach the surface near the sternum. Occasionally an abscess forms on both sides of the spine at once. In the cervical region the abscess will point in the pharynx (*post-pharyngeal abscess*), or in the neck.

Process of cure.—Under favourable circumstances the granulation-tissue undergoes ossification without the production of any deformity; but after the deformity has taken place, and the vertebræ above and below the disease have come into contact by the falling forward of the upper portion of the spine, the destructive process, if the parts are kept at rest, may cease; and firm osseous ankylosis, but with a permanent angular curvature, will ensue.

Symptoms.—In the early stages, before the angular deformity is produced, pain is felt on percussion over the diseased vertebra, or better on the head of the rib in connection with it, or on gently pressing on the shoulders, or tapping on the head, or on applying hot sponges to the spine. Pain also is felt in the course of the intercostal nerves and hence in the case of the lower intercostals may be referred to the abdomen. It is increased on movement; hence the spine is held stiffly by the muscles. The movements of the child are characteristic. If asked to pick up anything he does not bend his back, but placing his hand upon his knee to support his spine, reaches the ground by bending his legs and holding his back straight. If asked to turn round, he rotates the whole body, not the back. He walks about supporting his spine by resting his hand on the various portions of furniture, and soon gets tired of play, and is noticed to lie about on the floor. In older patients tingling or numbness may be complained of in the extremities, and a feeling as if a cord were tied tightly round the body. Later, a prominence of one or more vertebræ occurs, and the nature of the disease can no longer be doubted. If neglected, the prominence increases, and the well-known angular deformity is produced. Now, especially if the disease is high up the spine, some loss of motion in the lower extremities occurs, and may progress to complete paralysis of motion. Sensation is not usually affected, as the posterior columns, being remote from the disease, escape. Nor are the bladder and rectum usually implicated. If an abscess has not already formed, and especially if the disease is moderately low down, one may now present in the loin (*lumbar abscess*), in the iliac fossa (*iliac abscess*), or in the groin (*psoas abscess*). The first gives rise to a fluctuating tumour between the last rib and the crest of the ilium just external to the erector spinæ; the second to a swelling in the iliac fossa. The *psoas abscess* may be known by the swelling being at first external to the femoral vessels, by the impulse on cough, and by fluctuation being detected on pressing above and below Poupart's ligament. The abscess makes its way under the femoral vessels, and then generally points at the inner and upper part of the thigh, and there breaks. After the opening of these abscesses hectic but too frequently sets in, and the patient succumbs to the long-continued suppuration producing exhaustion or lardaceous disease; or he is carried off by tubercle in the lungs or other organs. Under more favourable circumstances the abscess may heal, firm ankylosis of the spine occur, and the patient recover with a permanent hump-back.

Diagnosis.—In the early stages caries must be diagnosed from neuralgia, rheumatism, lumbago, aneurysm, tumours, and hysteria; in the later stages the angular curvature may have to be diagnosed from the kyphotic curvature of rickets. From *neuralgia*, *rheumatism*, and *lumbago* it is not always easy to distinguish it. The history of a former rheumatic attack, the effect of remedies, and the absence of the signs given above, must then be relied upon. *Hysteria* may simulate it very closely. The absence of signs of caries, except pain; the inconstant and more diffused character of the pain; and the presence of other signs of hysteria or of uterine disease, are the points to be attended to. A careful auscultation of the chest and examination of the abdomen will usually serve to exclude *aneurysm*. From *tumours* of the vertebral bodies, leading to the breaking down of the vertebræ, caries cannot at first be diagnosed, as both give rise to the same symptoms, but the age of the patient and the presence of a carcinomatous growth elsewhere would lead to suspicion of cancer. The curve of *rickets* is more generally kyphotic, and disappears more or less completely on gently holding the child up by its arms, or extending it with its face downwards across the nurse's knees. There are, moreover, concomitant signs of rickets, and absence of those of tubercle.

Treatment.—Both constitutional and local measures are required. The former are those already described under *Tubercle* (p. 48). The chief local indication is to keep the spine at rest in order that the diseased vertebræ may be placed in the most favourable condition for repair. This may be attempted in two ways:—1, by absolute recumbency; and 2, by the use of some form of spinal support. 1. *Absolute recumbency* from six to twelve months in the supine or prone position on a suitably constructed couch is the best method of treatment where the patient can be properly cared for, has airy apartments, can be taken out in this position in an invalid carriage, and can reside in the country or at the seaside. Especially is this treatment the best when the disease is situated high up in the spine, *i.e.*, in the upper dorsal or cervical region, and it is imperatively necessary where there is paralysis. To ensure absolute recumbency I have lately largely employed a double Thomas's splint (Fig. 299), modified by the addition of a pelvic band, a support for the shoulders, neck and head, and two sliding foot-pieces. The two upright bars, which are prolonged to the head support, are made after the shape of a normally formed child when in the recumbent position, and give support to both sides of the spine. Two cross-bars support the body, just below the axillæ and pelvis respectively; the legs are kept in position by the ordinary circlets and foot-pieces. The splint is placed next the skin so as not to require removal while the child is washed, dressed, &c. It not only fixes the spine and takes off the weight of the head and upper limbs, but also fixes the lower limbs, and thus prevents the psoas muscles from dragging on the spine. Absolute recumbency, when properly carried out, offers the best prospect of averting serious angular deformity and paralysis; as soon, however, as the acute symptoms quiet down some form of spinal support should be applied, and the patient cautiously allowed to take a certain amount of exercise. But amongst the poor, where the children are often left to themselves during the greater part of the day, absolute recumbency can seldom be ensured; and if it could, its advantage over other methods would be counterbalanced by the severe detriment to the health which the child would suffer in consequence of confinement to an ill-ventilated room, &c. For such patients some form of support, not only to restrain as much as possible the motions of the spine, but also to allow them to obtain a certain amount of fresh air, is generally necessary. 2. The *supports* most in use at the present day are Sayre's plaster-of-Paris case and Cocking's poroplastic felt jacket, though some surgeons still prefer steel instruments. The plaster-of-Paris case may be applied with the patient either in the upright position, suspended, with his heels just off the ground, by Sayre's tripod, or in the recumbent position by Davy's hammock apparatus. A skin-fitting vest having been previously applied, and a line drawn across the back with a pencil at the level of the axillæ

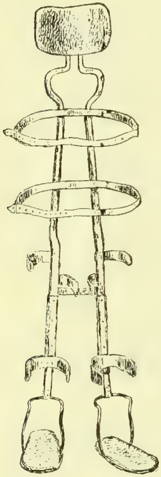

FIG. 299.—Double Thomas's splint for spinal caries.

to indicate the upper limit of the jacket, crinoline bandages, impregnated with plaster of Paris, are wound round and round the trunk till a sufficient thickness is obtained, dry plaster being from time to time rubbed in with the hands. The case should reach from the pencil line to just below the crest of the ilium, stopping short of the great trochanter and the pubes, and may be strengthened, if necessary, in places by inserting strips of perforated tin vertically between the bandages. Before applying the bandages, a folded silk handkerchief should be placed over the abdomen beneath the vest, so that when afterwards withdrawn space will be left for abdominal respiration (*Sayre's stomach-pad*). When the plaster case is dry it may be sawn through down the front, removed, and the fronts edged with leather, and perforated with eyelet-holes, so that it can be worn laced up, and be taken off from time to time. To apply the poroplastic felt, the jacket, which is first made to measure, must be put in a steam oven, and when rendered thoroughly plastic, further moulded to the patient, who should be prepared and suspended in the same way as for applying plaster of Paris. Of steel instruments, that known as Taylor's is perhaps the best. In my own practice, however, I almost invariably employ the poroplastic jacket. Where the disease is in the cervical or upper dorsal region, Sayre's jury-mast may be fitted to the plaster-of-Paris case or poroplastic jacket; or a cervical collar composed of leather or poroplastic felt may be used, or better, the combined poroplastic jacket and collar devised by the author. Should an abscess form, it should be treated in the way described under *Chronic Abscess*. In some cases where necrosis has been associated with caries, success has attended the removal of the sequestrum through a properly-planned incision made in the loin. In exceptional cases in which the paralysis of the lower limbs continues, in spite of absolute rest and recumbency, and in which there is intractable cystitis or severe pain not relieved by ordinary measures, the spines and laminæ of the affected vertebræ may be excised for the purpose of relieving pressure on the cord. (*Laminectomy*.) The compression of the cord, however, would appear to more often depend on the presence of a tuberculous collection in front of the cord than on displacement of bone. Unless the tuberculous abscess, therefore, can be evacuated, the removal of the arches of the vertebræ is futile, and only tends to weaken the vertebral column. In place of laminectomy, an attempt may, in suitable cases, be made to reach the tuberculous collection from the front of the vertebræ. Ménard has succeeded in doing this by excising the transverse processes and proximal end of the ribs corresponding to the most prominent part of the spinal curve. Through the aperture thus made he was able to scrape and wash away tuberculous material with the result that the paralysis quickly disappeared.

Occipito-atloid, and atlo-axoid disease, are terms applied to chronic tuberculous inflammation attacking the articulations between the occipital bone and the atlas, and the atlas and the axis respectively. Hence, the disease resembles in its course tuberculous disease of the joints, rather than tuberculous disease of the bodies of the vertebræ. It may begin either in the synovial membranes, or as caries of the bones forming the articular processes, and when occurring between the atlas and the axis usually affects the synovial membranes between the odontoid process and the transverse ligament on the one hand, and the tubercle of the atlas on the other. Indeed in this situation it would appear to often begin as a caries of the odontoid process itself, and then spread to the synovial membranes. The disease is often attributed to a sprain of the neck, but though it may sometimes be excited by such, would appear more probably to depend on causes similar to those leading to tuberculous disease elsewhere.

Symptoms.—Pain is first felt over the seat of the disease, and radiating in the course of the nerves emerging from the intervertebral foramina between the affected bones. It is increased on attempting to turn or nod the head, but is relieved by supporting the chin with the hand. Hence the patient often holds his head between his hands, and if asked to rotate it, turns his whole body, keeping his neck stiff and immovable the while. When the disease is chiefly limited to the articulations between the occipital bone and the atlas, the pain is principally confined to the region supplied by the suboccipital nerve, and is increased on nodding rather than on rotating the head. As the disease advances, the atlas, with the occipital bone, has a tendency to slip forward on the axis—directly forward if both sides are equally diseased, or more to one side if the disease is unilateral. The spine of the axis in consequence appears more prominent than natural, and the head on a plane anterior to that of the rest of the spinal column. Should an abscess form it may point at the back of the pharynx (*post-pharyngeal*) or at the side of the neck. *Treatment.*—Absolute rest on the back, with the head between sand-bags, is imperative, as there is danger of fatal compression of the cord from the odontoid process or the transverse ligament giving way during some sudden movement of the patient. In some cases attended with paralysis below the disease, continuous extension and counter-extension, with the patient in the recumbent position, has been successful in removing the pressure from the cord. When the acute symptoms have subsided, a moulded collar of leather or poroplastic felt, or an inflating india-rubber collar, will be required. Should an abscess form it should be opened in the neck if possible rather than through the mouth.

Spina bifida "is a congenital malformation of the vertebral canal with protrusion of some of its contents in the form of a fluid tumour." It is nearly always met with in the middle line of the back, but very exceptionally the protrusion has occurred through the bodies of the vertebræ instead of posteriorly through the cleft spines. It is due to an arrest of development of the laminæ of the vertebræ (*mesoblastic elements*), and their consequent failure to unite in the middle line to form the spinous processes. This non-union may possibly be sometimes owing to an excess of cerebro-spinal fluid. A spina bifida may occur in any part of the spine, but is most common in the lumbo-sacral region, where the laminæ are the latest to unite. It may be associated with partial paraplegia or contracture, incontinence of urine and fæces, and with club-foot or other congenital deformities.

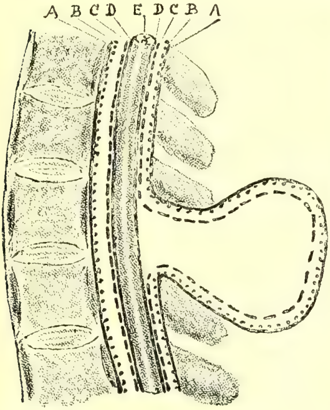

Fig. 300.—Spinal meningocele.

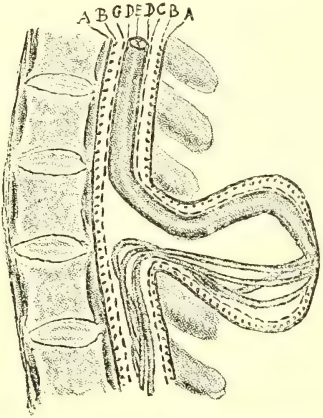

Fig. 301.—Meningo-myelocele.

In the three diagrams (Figs. 300, 301, and 302) the letters have the same reference. A. Dura mater. B. Parietal, and C. visceral arachnoid. D. Pia mater. E. Cord.

Pathology.—Three chief forms of spina bifida are described:—1, spinal meningocele, 2, meningo-myelocele, 3, syringo-myelocele. 1. In *spinal meningocele* the sac (Fig. 300) consists of dura mater and arachnoid blended together, and consequently communicates with the sub-arachnoid space and contains cerebro-spinal fluid. The cord and nerves remain in the spinal canal. Very rarely the sac is said to consist of dura mater only, *i.e.*, of dura mater and so-called parietal layer of arachnoid; it would then communicate with the subdural space instead of with the sub-arachnoid. 2. In the *meningo-myelocele* (Fig. 301), the most common form, the sac also consists of dura mater and arachnoid, but contains in addition to cerebro-spinal fluid the spinal cord and nerves, which are often spread out over and intimately blended with the posterior part of the wall of the sac. As the cord passes through the sac some of the large nerve-cords given off from it run forwards across the interior of the sac to re-enter the spinal canal. Hence those nerves that are given off from the cord where it is adherent to the sac wall, appear to arise from the sac, and were in former times wrongly described as being distributed to it (see Fig. 301). 3. In the *syringo-myelocele* (Fig. 302), the most rare form, the central canal of the cord is greatly distended with fluid, the expanded cord being thus spread out over the sac wall, with which it is intimately blended. The nerves in this case pass through the walls of the sac to their destination.

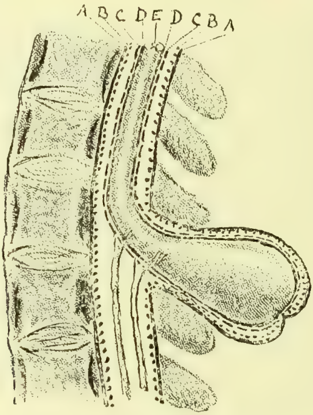

FIG. 302.—Syringo-myelocele.

The coverings of the sac may be healthy skin; but more commonly normal skin is only found at the sides, the central portion consisting of a thin bluish membrane. Sometimes a slight depression is seen on the lower part of the sac at the spot where the cord terminates in the wall. This is called the *umbilicus*, and at its bottom the central canal of the cord has at times been seen to open.

In some instances there is no protrusion, but rather a depression in the situation of the cleft between the vertebræ (*spina bifida occulta*), the cleft being occupied by the blended membranes, cord, and skin, and the spot covered with a tuft of hair. In obscure paraplegias, and in contractures and deformities of the feet, the back should be examined, since this condition may be present though overlooked by the mother.

Symptoms.—The swelling is usually of a globular or oval shape, translucent, sessile or slightly pedunculated and flaccid, but becomes tense and distended on coughing or crying. Pressing upon it sometimes causes the fontanelles to swell up, and may produce convulsions. When the spinal cord and large nerves are involved, there may be paralysis of the extremities or of the bladder or rectum. The gap between the laminæ of the vertebræ may at times be felt on pressing on the sac. As a rule these tumours show a great tendency to enlarge, and rupture spontaneously, in which case death usually follows from the draining away of the cerebro-spinal fluid, and septic meningitis. Death, however, is sometimes due to marasmus and defective nutrition. When a spontaneous cure takes place it is usually due to the gradual shrinking of the sac.

Diagnosis.—Its congenital origin will at once distinguish a spina bifida from a new growth developed subsequently to birth; and its situation in the middle line, translucency, increase of tension on straining, and the gap between the laminæ when this can be felt, will usually serve to diagnose it from other congenital tumours.

Treatment.—As there are no means of accurately determining that the spinal cord is not in the sac, it has hitherto not been considered safe to attempt excision or ligature, although these operations have at times been attended with success. Repeated tappings are very fatal. The treatment usually employed, except when the spina bifida is very small or is apparently undergoing a spontaneous cure when it should be left alone, is to inject the sac with Dr. Morton's iodo-glycerine fluid. This method when successful causes the tumour to shrink, and most closely follows the process of nature when a spontaneous cure occurs. The injection is best performed when the child is two months old; but it may be done earlier if the sac threatens to burst. "The best results may be expected when there is no hydrocephalus or paralysis, and the sac is covered by healthy skin." It is contra-indicated when there is "advanced marasmus, great and increasing hydrocephalus, and intercurrent disease." The child should be placed on its side, and the puncture made obliquely through healthy skin on one side of the base of the tumour, and not through the thin and imperfectly formed skin which nearly always covers the sac in the middle line, "the object being to avoid wounding the expanded spinal cord, and the subsequent leakage of the cerebro-spinal fluid." About a drachm of the iodo-glycerine fluid (iodine, grs. x.; iodide of potassium, grs. xxx.; glycerine, ℥j.) should be injected, and the injection repeated in a fortnight if the first trial is not successful. The fluid contained in the sac should not be drawn off before the injection. The advantage of Morton's fluid over tincture of iodine alone is that, owing to the glycerine it contains, it becomes uniformly diffused over the sac walls. The injection of iodo-glycerine is not unattended with danger: therefore when the sac is small and its walls are thick, and it is not increasing in size, beyond protecting it with a metal or leather shield, no further treatment should be attempted. Mayo Robson advocates excision in all cases except where there is well-marked paraplegia, hydrocephalus or marasmus, or where the tumour is small and well covered by a firm pad of integument. In spinal meningocele two vertical skin flaps are made, the sac excised, the base ligatured or sutured, and the skin flaps brought together by suture. In meningo-myelocele the skin is reflected from the sac, the latter opened, the nerves and cord dissected from the sac wall, and returned into the spinal canal. The sac is now excised, the meningeal pedicle ligatured or sutured, and the skin flaps brought together over it, care being taken that the lines of suture in the meninges and skin are not placed opposite each other.

SURGICAL DISEASES OF THE INTESTINES.

INTESTINAL OBSTRUCTION.

The pathological conditions that may give rise to intestinal obstruction are very various, and may be considered under the following heads:—

1. IMPACTION OF FÆCES, GALL-STONES, OR FOREIGN BODIES IN THE INTESTINES.—An accumulation of hardened fæces may occur as the result of habitual or accidental constipation, and is then nearly always met with in the large bowel, and especially in the region of the cæcum or in the sigmoid flexure and rectum. The impaction of gall-stones or intestinal concretions, though more rare, is also met with, but usually in the small intestines. Obstruction from these causes is more common in women than in men. Foreign bodies that have been swallowed, though they usually escape at the anus, may become impacted in any part of the intestine, but especially in the lower part of the ileum, the cæcum and rectum.

2. INTERNAL STRANGULATION OR INTERNAL HERNIA.—These terms are applied to obstruction of the intestine by some constricting agent within the abdomen. The strangulation may be effected by: 1. Bands produced by the stretching of old inflammatory adhesions, the result of former peritonitis. These are more particularly common about the mouths of old hernial sacs. 2. The remains of some fœtal structure, as the omphalo-mesenteric duct (Meckel's diverticulum), &c. 3. A coil of intestine slipping through a hole in the mesentery or omentum. 4. A coil of intestine passing into a pouch of peritoneum (*retroperitoneal hernia*) as the duodeno-jejunal, the sigmoid, or one of the ileo-cæcal pouches.

3. VOLVULUS is a twisting or kinking of a coil of intestine, so that its calibre is completely obliterated at the twisted or bent spot. Accumulation of flatus, excessive peristalsis due to gall-stones, constipation and unequal distension have been assigned as causes. Volvulus is said to be most common in the sigmoid flexure; and always to be situated towards the back of the abdominal cavity. The intestine may be—1, simply bent upon itself; 2, twisted round its mesentery; and 3, wound round another coil of intestine. The first form only occurs in the colon; the second in the small intestine; the third form usually consists of the colon wound round a coil of small intestine, the sigmoid flexure, or the cæcum.

4. INTUSSUSCEPTION (Fig. 303) is the invagination of a portion of intestine into the lumen of the intestine immediately below. The intestine thus forms three tubes, one within the other, an outer, middle, and inner (Fig. 304). The external tube is called the *sheath*, or *intussuscipiens*, the innermost the entering tube, the

middle the receding or inverted tube, the last two together being further called the intussuscepted portion, or *intussusceptum*. Thus there are two peritoneal and two mucous surfaces of the intestine in contact (Fig. 304), and between the inner and middle tubes is a portion of the mesentery or meso-colon, which is necessarily drawn down with the intestine. The dragging of the mesentery causes the intussuscep*tum* to assume a greater curve than its sheath, and hence to become puckered along its concavity; it also causes the orifice of the intussuscep*tum* to be directed towards the mesenteric attachment and to be slit-like in shape (Fig. 303). The intussusception nearly always increases at the expense of the lower portion of the intestine, the sheath becoming more and more infolded, so that, if the intussusception occurs at the lowest part of the ileum, no more of the ileum will be involved, but the cæcum and colon may be gradually folded in. More rarely, however, the ileum is protruded through the ileo-cæcal valve; the intussusception then increases at the expense of the upper portion of the intestine, more and more of the ileum being protruded through the valve. Four kinds of intussusception are described. 1. The *ileo-cæcal*, the commonest form, in which the ileum and cæcum protrude into the colon, the ileo-cæcal valve forming the apex of the intussuscep*tum*. 2. The *ileo colic*, the least common, in which the ileum protrudes through the ileo-cæcal valve, the ileum forming the apex of the intussuscep*tum*. 3. The *colic*, in which part of the colon is invaginated into the colon below; and 4. the *enteric*, in which a portion of the small intestine is invaginated into a lower part of that bowel. At first the invagination

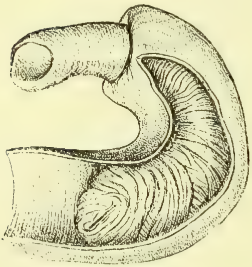

Fig. 303.—Intussusception. (St. Bartholomew's Hospital Museum.)

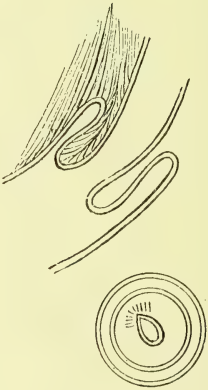

Fig. 304.—Diagram of intussusception.

is reducible, and is not attended with any serious obstruction to the lumen of the intestine. In this condition it may remain, in chronic cases, for several weeks or months. Or the mucous membrane of the intussuscep*tum* may become congested and swollen, rendering reduction difficult or impossible without rupture or other injury of the intestine. In the majority of cases, however, especially in infants, if the intussusception is not soon relieved, the blood-vessels of the involuted mesentery rapidly become constricted where the latter enters the sheath, causing acute obstruction to the circulation in the receding tube. As a consequence of this, the mucous membrane becomes intensely congested, and pours out the sanious discharge so diagnostic of the disease. In the meanwhile the contiguous peritoneal surfaces of the inner and middle tube become inflamed and glued together, rendering reduction impossible. Gangrene of the intussuscep*tum* now ensues, and the patient usually dies of collapse or peritonitis in a few days. In adults, however, and in children of six or eight years and upwards, the gangrenous portion may slough off at the constricted part and be passed per anum, but in children under two years of age the disease, unless relieved by treatment, is almost invariably fatal. Should recovery take place in this manner, the patient may subsequently succumb to stricture of the intestine, from contraction occurring at the spot where the intestine has united. The intussusception may measure only two or three inches in length, or it may involve the whole of the large intestine and protrude at the anus. It is attributed to worms, the dragging of a polypus, an elongated mesentery, irregular peristalsis, diarrhœa, and external violence. Its most common situation is at the ileo-cæcal valve, then in the small intestine, and then in the colon. It is rare in adults but common in children, especially in infants. The slight invaginations, often multiple, of the small intestine which may occur in the dying, must not be mistaken for true intussusceptions. In these the lower part of the intestine is often invaginated into that above.

5. STRICTURE OF THE INTESTINE CONSEQUENT UPON DISEASE OF THE INTESTINAL WALL.—This condition is generally due to the growth of a carcinoma or other tumour, such as an adenomatous polypus, more rarely to contractions following dysenteric, tuberculous or syphilitic ulceration, the passage of gall-stones, or injury, or operation on the intestine. It is most frequently met with in the large intestine, especially the rectum, and then in order of frequency, in the sigmoid, descending colon, splenic flexure, hepatic flexure and cæcum; it is rare in the small intestine.

6. CONTRACTIONS OF THE INTESTINE CONSEQUENT UPON DISEASE BEGINNING EXTERNAL TO THE INTESTINAL WALL.—This condition may depend on chronic peritonitis, or on carcinoma of the omentum or mesentery. It is more common in the small than in the large

intestine, and not only narrows the calibre of the bowel, but also obstructs the peristaltic action by gluing the coils of intestine to one another and causing contraction of the mesentery.

7. ACUTE PERITONITIS AND ENTERITIS are not uncommon causes of intestinal obstruction. Peritonitis is a frequent termination of the other conditions that cause obstruction, but it is perhaps most often due to inflammation spreading from the region of the cæcum (*peri-typhlitis*), the bursting of a peri-typhlitic abscess into the peritoneal cavity, or to ulceration, perforation, or gangrene of the vermiform appendix.

8. PERI-TYPHLITIS, TYPHLITIS AND APPENDICITIS.—*Peri-typhlitis* or inflammation localized to the peritoneum about the cæcum, is in the great majority of cases the result of appendicitis or inflammation of the vermiform appendix; more rarely of typhlitis or inflammation beginning in the cæcum itself. *Appendicitis* is nearly always the primary lesion in the condition formerly known as peri-typhlitis. It is a disease of adolescence, half the cases occurring under twenty, and it is three times more common in males than in females. Much attention in recent years has been given to the causation and pathology of appendicitis. It is believed that the remarkable frequency with which inflammation attacks this portion of the intestine is due in part to its anatomical peculiarities, viz.: dependent position, narrow mouth, short mesentery, single artery in the free margin of its mesentery, and removal from the direct fæcal current; in part to the lower resisting power that it possesses in common with other fœtal and archaic vestiges; and in part to the presence of the *Bacillus coli communis*, which, though inert so long as the epithelial lining is intact, becomes virulent and pyogenic so soon as any lesion is present. The immediate exciting causes of the inflammation are: 1. In the great majority of cases, habitual constipation, diarrhœa, or other digestive disturbance induced by improperly masticated or indigestible food. 2. Cold, or injury in the region of the groin. 3. The formation of fæcal concretion or the lodgment of a foreign body such as a fruit stone, pin, &c. 4. Still more rarely strangulation of the appendix in one of the cæcal peritoneal pouches. 5. Tuberculous, typhoid and malignant ulceration. In the more common form of appendicitis attributable to digestive disturbance it is believed that, in consequence of irregular distension of the ileum and cæcum, the peritoneal folds of the appendix become dragged upon, causing the appendix to become still further twisted and bent, and its blood supply, which is derived from the single vessel in the concave free margin of its mesentery, to be thus seriously interfered with. According to the amount of strangulation thus induced, congestion, swelling, catarrhal inflammation, ulceration or gangrene result. The *Bacillus coli communis* now comes into play, and a localized peritonitis is

set up about the appendix and cæcum. This may terminate in (1) a localized abscess, limited by the adhesion of the coils of intestine to each other; (2) a retro-peritoneal abscess, and (3) general peritonitis.

Several *varieties* of appendicitis are described:—(*a*) The *catarrhal*. In this the mucous membrane is greatly swollen, narrowing the lumen of the tube in one or more situations, whilst the parts beyond may become greatly distended with mucus, or muco-pus, or calcareous concretions may form in it, and become coated with fæcal matter. Finally the *distended* part may give way, producing a localized or general peritonitis;—(*b*) The *gangrenous*. In this form the torsion is so extreme that the vascular supply is cut off and the whole or part of the appendix passes at once into a state of gangrene, and sets up either a localized abscess or diffuse septic peritonitis;—(*c*) *Obliterative appendicitis*. In this form the lumen of the tube becomes constricted in several situations, and finally the whole calibre becomes obliterated, and the appendix reduced to a fibrous cord;—(*d*) *Recurrent or relapsing appendicitis*. In this, attacks of acute inflammation occur from time to time, with intervals of partial or complete cessation of the symptoms.

9. MECHANICAL PRESSURE ON THE INTESTINE by innocent or malignant growths, hydatid cysts, enlarged glands, &c., may occasionally give rise to obstruction.

10. CONGENITAL MALFORMATION OF THE INTESTINE.—Amongst the chief of these may be mentioned imperforate anus, deficiency of the rectum, absence of the colon, termination of the colon in the bladder, &c. Obstructions from such and like causes are only met with in the infant (*see* Diseases of Rectum, p. 672).

11. EXTERNAL HERNIA.—All forms of external herniæ when strangulated, and generally when incarcerated or inflamed, are productive of intestinal obstruction (*see* Hernia, p. 636).

12. PARALYSIS OF THE MUSCULAR COAT OF THE INTESTINE (*Adynamic intestinal obstruction*).—Obstruction sometimes occurs solely as the result of loss of power in the muscular coat of the intestine. This form of obstruction may be due to the excessive formation of gas during an attack of dyspepsia, or it may follow abdominal section, an operation for strangulated hernia, or operations on the rectum.

Termination of intestinal obstruction.—Whatever the cause of the obstruction, the intestine above becomes sooner or later enormously distended with fæcal matter (Fig. 308) and flatus, and if the obstruction be not removed the case will end fatally from exhaustion, peritonitis, ulceration or rupture, followed by collapse and peritonitis, or septic poisoning by the toxines of the *Bacillus coli communis* (*Coli bacillosis*). When rupture occurs it is usually the cæcum that becomes most distended and gives way, the rupture being in some cases preceded by superficial ulceration (*stercoral ulcers*).

The SYMPTOMS of intestinal obstruction vary according to the pathological conditions upon which the obstruction depends. The symptoms common to all may be said generally to be pain, vomiting, constipation, and more or less distension of the abdomen. When the *obstruction occurs suddenly*, and is attended by *strangulation* of a portion of intestine, as in 1, the various forms of constriction produced by bands; 2, a portion of intestine slipping through a hole in the mesentery or omentum; 3, volvulus; and 4, external strangulated hernia, the symptoms are also *sudden* in their onset and *acute* in their course, as is likewise generally the case when they depend upon intussusception, the impaction of a gall-stone or other foreign body, the sudden accumulation of fæces above a stricture, appendicitis or peri-typhlitis, or acute enteritis or peritonitis. Thus the pain is severe and violent, occurs suddenly in a person in previously good health, and is generally referred to the umbilicus, *i.e.*, about the region of the solar plexus; the vomiting comes on early, and may rapidly become fæcal; the constipation is complete from the first; flatus will not pass by the anus; the urine may be scanty or suppressed; there is frequently hiccough and tympanites; the temperature is below normal; the pulse rapid and feeble; the tongue is coated and soon becomes dry and brown; the face is pale and bathed in cold sweat; the collapse increases; and the patient dies of septic poisoning. When, on the other hand, the *obstruction comes on more slowly*, and a portion of the intestine is *obstructed* rather than *strangulated*, as from (1) progressive stricture of the rectum or colon; (2) the pressure of an abdominal or pelvic tumour; (3) the gluing together of the intestines by chronic peritonitis or cancer; (4) the gradual accumulation of fæces, due to habitual constipation, and (5) chronic intussusception; the symptoms are also *insidious* in their onset and *chronic* in their course. Thus, obscure abdominal symptoms may have existed for some time. The pain is less severe, more diffused, and may be intermittent, but increases with the distension. Vomiting only occurs late in the course of the affection, and does not become fæcal till towards the last. Constipation is not complete at first, the motions may be scybalous, and there may be a history of alternating constipation and diarrhœa. The distension of the abdomen is gradual and is, perhaps, more marked in the lumbar and epigastric regions. The abdomen appears broad, and coils of intestine may be visible owing to increased peristalsis consequent upon hypertrophy of their muscular coat; gurgling sounds are often heard in the abdomen. The urine is normal. A stricture may perhaps be felt in the rectum by the finger, or in the sigmoid flexure by passing the hand, or a tumour may be discovered. Collapse does not come on till the end. Such, broadly, may be said to be the symptoms attending acute and chronic intestinal obstruction. But it must not be forgotten that the conditions which commonly give rise to chronic symptoms may, at any time, suddenly terminate in complete obstruction and strangulation, when the symptoms will at once become acute. Thus a slowly contracting stricture may become suddenly obstructed by the impaction of fæces, or by a portion of intestine immediately above becoming invaginated into it; or acute peritonitis may suddenly supervene, owing to the giving way of an ulcerated portion of intestine above a stricture, &c.

The DIAGNOSIS of the various pathological conditions causing obstruction or strangulation of the intestines, though sometimes comparatively easy, is often very difficult, or even impossible. Your first care, when called to a patient with signs of acute abdominal obstruction, *i.e.*, pain, vomiting, constipation, and possibly distension of the abdomen, should be to exclude external strangulated hernia, not merely contenting yourself with examining the femoral and inguinal rings, but also making a careful search in the less common situations of hernia, as the obturator foramen and sciatic notch. Should there be any fulness, or the least suspicion of strangulation in any of these regions, an exploratory incision should be made. Having satisfied yourself of the absence of external hernia, you should next carefully examine the abdomen by inspection, palpation, percussion, and auscultation with the phonendoscope, and explore the rectum and vagina with the finger; whilst the former canal may, in some instances, be further examined by carefully passing a long enema-tube or even by introducing the whole hand. At times something may be learnt by cautiously inflating the colon with hydrogen gas or air, or by slowly distending it by the fountain syringe with fluid, the patient being in the genu-pectoral position. Senn has shown that gas will pass the ileo-cæcal valve, causing, as it does so, a distinct rushing sound, with diminution of pressure as indicated by the mercurial manometer attached to the inflating rubber-bag. If there is no obstruction the gas can be forced through the whole intestine and out at the mouth. Should (*a*) a hernia be discovered exhibiting well-marked local signs of strangulation; or (*b*) a distinct tumour be detected in the abdomen or pelvis; or (*c*) on introducing the finger into the rectum a stricture be felt; or (*d*) the bowel be found loaded with hardened fæces; or (*e*) blood and slime escape from the anus and a sausage-shaped tumour be detected in the abdomen or rectum; or (*f*) a localized and tender swelling be discovered in the right iliac fossa, the diagnosis of (*a*) strangulated hernia, (*b*) a new growth obstructing the bowel, (*c*) stricture of the rectum, (*d*) impaction of hardened fæces, (*e*) intussusception, and (*f*) appendicitis or peri-typhlitis respectively can be readily made. But when, on the other hand, the hernial rings are found free, the rectum empty, and nothing can be felt in the abdomen, the difficulty of localizing the cause of the obstruction is great, and even after the most careful examination and thoughtful consideration of the symptoms it may only be possible to arrive at an approximate guess as to the nature of the case. Thus, if the symptoms are acute, the obstruction will probably be due to some form of internal strangulation or to a volvulus; but it must not be lost sight of that it may be due to appendicitis or peri-typhlitis, acute enteritis or peritonitis, or possibly to the impaction of a gall-stone. If the symptoms are chronic it may be due to stricture in the upper part of the rectum or lower part of the colon, malignant disease of the omentum or intestine, or chronic peritonitis. If acute symptoms have been engrafted on chronic, it may then be caused by the impaction of fæces above a stricture, peritonitis following perforation above a stricture, or the giving way of a distended vermiform appendix' or the rupture of a peri-typhlitic abscess. Although it may be impossible to make a diagnosis, the following considerations may help us. Thus, if the onset of the symptoms is sudden and the patient is an infant or a young child, the cause of the obstruction will probably be intussusception or peritonitis. If the patient is elderly or middle-aged, and the symptoms are chronic, malignant stricture or impaction of fæces is the most probable cause. In middle age intussusception is rare. The tendency to vomit is in proportion to the nearness of the obstruction to the stomach, the tightness of the constriction, and the persistence with which food or fluid has been taken by the mouth. Early vomiting implies tightness of the stricture; violent retching or bile-vomiting points to gall-stones; fæcal vomiting only occurs when the obstruction is moderately low down. Vomiting may be absent in obstruction of the colon or rectum. Finally, if peristalsis is visible, the case is almost certainly not one of acute peritonitis.

1. In *impacted fæces* there may be a history of previous constipation, the rectum will probably be found distended, or fæces will be passed on the use of enemata. A swelling may be felt through the abdominal parietes, and if so will be soft, and can perhaps be indented with the fingers. In *obstruction from gall-stones*, there may be pain in the region of the gall-bladder, perhaps jaundice; gall-stones may have passed, or similar attacks have been previously suffered from, and the bowels may have acted irregularly. The vomiting is gastric or bilious, and is attended with violent retching. If the obstruction is due to a *foreign body* there will probably be a history of one having been swallowed, and it might possibly be detected by the x rays.

2. In *internal strangulation* the attack is very sudden, and is probably attributed to a strain; the pain is intense, and is referred to one spot, or to the umbilicus; vomiting comes on early and gives no relief; the constipation is sudden; there is no desire to defæcate;

the urine is scanty; there is no visible peristalsis; no tumour can be felt; there is no hæmorrhage from the bowel, and no tenesmus; the abdominal walls are not tense. There is probably a history of some affection which might produce bands of adhesions, as peritonitis, typhoid fever, or a former hernia; or there may have been previous attacks of abdominal obstruction with intervals of perfect health.

3. In *volvulus*, the signs are similar to the foregoing, but if anything still more severe. Meteorism comes on early and is well marked. The patient is probably over forty years of age, and has suffered from constipation. The sigmoid flexure may be visible. There may be some tenesmus, and the vomiting may relieve for a time.

4. In *intussusception*, when *acute*, there is a discharge of mucus and blood from the anus with usually marked tenesmus; the pain is intermittent; the abdomen is not much distended; meteorism is absent; the abdominal parietes are usually lax, and through them a sausage-shaped tumour, doughy to the feel, hardening on handling, and perhaps changing its position from time to time, may sometimes be detected; and the invaginated bowel can possibly be felt in the rectum. In the ileo-cæcal form the resistance in the right iliac fossa may be decreased (*signe de Dance*). Collapse soon ensues. When *chronic*, there may have been attacks of localized pain lasting for months before strangulation occurs, the patient having been in good health in the intervals. There is straining and tenesmus; the constipation is not complete; vomiting is absent or intermittent; the distension is not marked; and collapse does not come on till the end. The tumour will have characters similar to those mentioned above.

5. In *stricture* the patient is usually old or middle-aged; the symptoms come on very insidiously; there are alternate attacks of constipation and diarrhœa; the constipation gradually becomes more and more pronounced; the motions are probably lumpy (*scybalous*), pipe-like, or flattened; dyspepsia is complained of; the pain is diffused and depends upon the distension of the abdomen; the distension comes on slowly, and is greatest in the flanks; peristalsis is visible; the urine is copious; the pulse quiet; and vomiting only occurs late in the case. Having diagnosed the case as one of stricture, the next point to determine is whether it is situated in the sigmoid flexure or rectum, and consequently that opening the sigmoid flexure in the left groin or the descending colon in the left loin, will be well above the stricture; or whether it is situated in the descending, transverse, or ascending colon, so as to necessitate the opening of the ascending colon or cæcum. To begin with, it should be remembered that stricture is most common in the sigmoid flexure and rectum, next in the colon, then

in the cæcum, and is very rare in the small intestine; indeed it is so rare in the two latter situations, that when its exact position is not known, it is generally safe to assume that right colotomy or typhlotomy will suffice. Again, if the stricture is in the rectum or sigmoid flexure, the distension will be equal on the two sides; when in the descending or transverse colon, greater on the right than on the left side. The amount of distension on the two sides may be more accurately estimated by the cyrtometer than by mere inspection and palpation. If a clyster-pipe will pass for some distance, say a foot or so, and a large quantity of fluid can be injected, the stricture is probably high up; but too much importance must not be attached to this sign, as the clyster-pipe may have bent upon itself and the rectum and sigmoid flexure are often very capacious. Further, something may at times be learnt by auscultating the colon, especially with the aid of the phonendoscope whilst the injection is being given, and by passing the whole hand into the rectum. The detection of a tumour in any part of the colon or cæcum will, of course, set the diagnosis at rest.

6. In *contractions* there is pain of a paroxysmal nature, of short duration and of frequent occurrence; peristalsis may not be visible on account of the matting together of the intestines, but gurglings may be heard. There is no vomiting or distension except during the attacks of pain. Constipation is not complete; defæcation is painless; the motions are not compressed or pipe-like as they may be in stricture; and there is no distension in the flanks. The symptoms may at any time suddenly become acute.

7. In *acute peritonitis* the abdomen is distended from the first, hard, and board-like; peristalsis is not visible; the pain is great and increased on the least pressure; the pulse is small and wiry; the temperature may or may not be raised. (See *Peritonitis*, p. 395.) There will probably be a history of previous attacks of appendicitis or peri-typhlitis, or signs of gastric ulcer, or the patient is suffering from typhoid fever or has had uterine or ovarian troubles, &c.

8. In *appendicitis* or *peri-typhlitis* the symptoms may set in gradually, but more often begin with an attack of acute pain, especially in the gangrenous variety. The pain is at first diffused over the abdomen or referred to the umbilicus, but soon becomes localized, more or less, to the region of the cæcum. The tongue becomes furred, later dry, the appetite lost, the bowels confined, and the temperature raised. In acute cases there may be nausea or even vomiting, and in the gangrenous variety more or less collapse, and signs of acute diffuse peritonitis. The abdomen becomes distended. At first there is increased resistance and tenderness in the right iliac fossa, whilst later a distinct swelling may be felt extending inwards towards the middle line upwards to about the level of the umbilicus and more or less backwards into the loin.

Still later, fluctuation in the swelling may be detected. The tenderness is often most marked at a spot two inches from the anterior superior spine of the ilium, on a line between that spine and the umbilicus (*McBurney's point*), *i.e.*, over the situation of the appendix. There is probably a history of constipation or irregular action of the bowels, or of one or more previous attacks of a similar nature.

9. In *mechanical* pressure on the intestines by new growths, cysts, enlarged glands, &c., a tumour will probably be discovered on palpation of the abdomen or by the finger in the rectum or vagina.

10 and 11. The diagnosis of *congenital malformation of the rectum* and *external hernia* are given under these heads respectively.

12. In obstruction due to *paralysis of the muscular coat of the intestine*, the most prominent sign is perhaps tympanites, which, as a rule, extends over all the abdomen. There is also constipation, inability to pass flatus, and, frequently, vomiting, which, in extreme cases, may become fæcal, and restlessness and pain from the abdominal distension. The presence of general tympanites, and the absence of signs of organic obstruction, and especially of peristaltic movements are the points to be chiefly relied on. In this form of obstruction the symptoms may so closely resemble those due to mechanical causes that the abdomen has frequently been opened in the belief that such existed.

Treatment.—Supposing any of the above conditions to have been diagnosed with tolerable certainty, the indications for treatment will be clear (see below). Where no diagnosis, however, can be made, the treatment may at first be expectant, but no long delay is admissible if surgery is to have a fair chance of saving the patient. Thus in *acute cases*, nothing whatever should be given by the mouth, not even ice to suck, and subcutaneous injections of morphia should be entirely withheld since the relief they give is only deceptive, and valuable time is thus lost. When the patient is much collapsed he should have an enema of brandy (℥j) and milk (℥iij), and be well wrapped up in hot blankets, and surrounded by hot bottles. The surgeon will now do well to follow the advice of Mr. Greig Smith, namely, to sit by the patient for half-an-hour or so. "As the shock passes off," says that surgeon, "the natural evolution of special signs comes on. These are carefully and patiently observed by sight, touch, and hearing, and their interpretation is the diagnosis. But their evolution being slow and complex, and their meaning often obscure, he must wait while they repeat themselves again and again, and not leave the patient's side till solid reasons have been found for a definite line of treatment." Having arrived at a diagnosis, or a sufficiently approximate diagnosis, the surgeon may now proceed to deal with the case as set forth in the special sections on the subject, but if the diagnosis still remains doubtful, and the patient's condition continues such that he would probably not bear the shock attending exploration, a small incision may be made through the abdominal wall, and the first piece of distended intestine that presents secured to the edges of the wound, and opened (*Enterotomy*). Later, when the distension has been relieved, and the patient's condition has improved, means may be taken for dealing radically with the cause of the obstruction. In *chronic cases*, the diet should be restricted, only small quantities of the most digestible food being given at a time, and as soon as a diagnosis can be made, measures should of course be taken for relieving, if practicable, the obstruction.

1. In *impacted fæces* when medical means and enemata have failed, the rectum may require clearing with a scoop or other suitable instrument. In *obstruction* from impacted *gall-stones* or other foreign bodies, after the usual remedies have been unsuccessful, the abdomen may be opened, and the gall-stone or foreign body removed through an incision in the intestine, or else made to pass by gentle manipulation through the ileo-cæcal valve. The incision should be made in the longitudinal axis of the gut, opposite the attachment of the mesentery, not over the impacted body, where the coats may be damaged, but a few inches higher up. The gall-stone or other body may then be removed, breaking it first if necessary, and the wound be afterwards united by Halsted's or Lembert's suture. Or should the walls of the gut be softened by ulceration, a portion of the intestine may be resected, and the continuity of the tube restored by one of the methods of enterorrhaphy described at p. 383. An impacted gall-stone may sometimes be broken up with a needle without opening the intestine.

2. In *internal strangulation*, abdominal section is the only procedure of any avail, and ought, like herniotomy, to be undertaken early and not merely as a last resource (see *Laparotomy*).

3. In *volvulus* of the sigmoid flexure, insufflation with air or hydrogen, or a large enema will at times succeed in untwisting the intestine. If these means fail no time should be lost in opening the abdomen (see *Laparotomy*). If there is a great distension, Treves advises that the inflated coil should be punctured through the abdominal parietes.

4. In *intussusception*, when *acute*, copious injections of warm water to empty the lower bowel, followed by insufflation of air or hydrogen, with the patient inverted and thoroughly relaxed under chloroform, will often succeed in the early stages, and should be given a fair trial. In the meantime opium may be given in doses suitable to the age of the patient, food withheld, and the stomach emptied by an emetic or irrigated with warm water. These means failing, laparotomy must be performed (see *Laparotomy*). If the signs of strangulation are well marked, too much time should not be lost in trying injections and insufflation, lest the bowel become

so damaged or the intussuscep*tum* so adherent to the intussuscip*iens* as to render the prospect of success hopeless. Indeed, I have come to the conclusion that unless laparotomy for intussusception in an infant is undertaken within twenty-four to thirty-six hours from the onset of the symptoms, reduction will be found next to impossible without so injuring the intestine as to render a fatal result almost inevitable. In infants intussusception, unless relieved by injections, inflations, &c., or by early operative means, may be said to be almost invariably fatal. In *chronic* cases, although there is less need for early operative interference than in acute, as the bowel may remain incarcerated for some time before becoming strangulated, it should not be delayed too long, lest the intussuscepted portion become adherent to the sheath. Should it appear probable that this has already happened, two courses are open: either to open the abdomen, or to keep the patient under the influence of opium in the hope that the intussusceptum may slough off and be passed *per anum*. In exceptional cases of intussusception of the sigmoid flexure the mass may be drawn out of the anus, the gut above and below united by sutures, the intussuscep*tum* cut away, and the united gut reduced.

5. For *stricture of the large intestine*, left inguinal colotomy should be performed when the obstruction is in the rectum or lower part of the sigmoid flexure, and typhlotomy when in the transverse or descending colon. Should the strictured portion be readily reached in performing the operation, it may, if the disease is localized, be cut out (*colectomy*, *typhlectomy*), and the bowel secured to the wound, or better, the two portions of bowel united. In *stricture of the small intestine*, enterotomy may be performed as a palliative, or, under suitable conditions, enterectomy with union of the intestines by one of the methods already described.

6. In *contractions*, where the intestines are matted together by chronic peritonitis or cancer, when medical means have failed, enterotomy may prove of temporary benefit by relieving the distension.

7. The treatment of *acute peritonitis* is given at p. 397.

8. In *Appendicitis*, *Perityphlitis*, *and Typhlitis*, widely different views are held as to the best course to pursue. Some hold that there is no medical treatment for appendicitis, and advise operation in every case. Others would restrict surgical interference to those cases in which an abscess has formed or diffuse peritonitis has been set up. There is no doubt something to be said in favour of early operation in every case, for as Morris of New York puts it, "the affected appendix is a cap which sometimes snaps, sometimes flashes, and sometimes causes an explosion, and none of us can tell in advance what is going to happen." Seeing, however, that some 70% of the cases recover spontaneously, and if the digestive disturbance is corrected may have no further trouble, the majority of

surgeons employ medical treatment before resorting to the knife. Thus the patient should be placed at absolute rest on his back, the diet restricted to milk, the bowel cleared by an enema, and hot belladonna fomentations or a few leeches applied over the region of the cæcum. Some give a little opium or morphia if the pain is excessive; others withhold opium altogether and insist on the advantage of clearing the bowel in the early stages by small doses of Epsom salts or calomel. In the *gangrenous form* and when perforation has occurred, all are agreed that the sooner the abdomen is opened and washed out, the better the chances of success. Should the inflammation terminate in suppuration and an abscess form, it should be opened and drained; but no attempt should be made to find the appendix, nor should the abscess be explored with the finger, flushed out or scraped, as such procedures only tend to break down the adhesions cutting off the general peritoneal cavity, and expose the patient to the risk of general septic peritonitis. Should such an abscess, however, have burst into the general peritoneal cavity, the peritoneum should be washed out and a glass drainage tube, or better, a gauze drain, left in the wound. The appendix, if found inflamed, plugged with a foreign body, ulcerated, or gangrenous, should be amputated, and the stump sutured by Lembert's method. In *relapsing or recurring appendicitis*, if careful attention to the digestion fails, the question of removing the appendix after an acute attack has subsided may be raised. The chief indications for this measure are (*a*) incapacity of the patient owing to the frequency of the attacks, (*b*) increasing severity of the attacks, (*c*) extreme severity of last attack, and (*d*) signs of local suppuration about the appendix. The incision should be made about two inches from the anterior superior spine of the ilium at right angles to a line drawn from the iliac spine to the umbilicus, or over the appendix if this structure, as is often the case when swollen and thickened, can be felt. The anterior muscular band of the cæcum is at times a good guide to the appendix. Adhesions having been carefully separated, and the appendix exposed, a circular incision should be made through its peritoneal coat about half an inch from its junction with the cæcum, the peritoneal coat reflected like a cuff, the remaining coats surrounded by a ligature, the appendix cut away, the surface of the stump disinfected by a drop of pure carbolic acid, and the reflected peritoneal coat sutured over it by Lembert's stitch. If extensive adhesions have formed, the operation is one of great difficulty and should not be lightly undertaken.

9. In obstruction from *mechanical pressure* measures must be taken, if practicable, to deal with the cause, as by the removal of a malignant or innocent tumour or enlarged glands, the draining or enucleating of an hydatid cyst, &c.

10 and 11. The treatment of *congenital malformations of the intestine*

and *external hernia* is given under Diseases of the Rectum (p. 672) and Hernia (p. 636).

12. In obstruction due to paralysis of the muscular coat a rectal tube should be passed to let the flatus escape and so allow the muscular coat to regain its tone.

LAPAROTOMY, ABDOMINAL SECTION, or opening the abdomen, is an operation that may be required for the purpose of exploration in doubtful cases of intestinal obstruction, or for the relief of volvulus, strangulation of the intestines by bands or diverticula, intussusception, reduction of hernia *en masse*, &c. The room should be at a temperature between 70° and 80° Fahr., and the patient, with the limbs wrapped in cotton-wool bandages, placed on a rubber bed filled with hot water. The greatest care should be taken that nothing septic comes in contact with the wound or peritoneal cavity. The stomach may be irrigated with warm water before giving the anæsthetic. This prevents vomiting, and may remove some of the contents of the upper part of the intestine and relieve distension. Some surgeons give a hypodermic injection of $\frac{1}{100}$th of a grain of atropine, and a rectal enema of brandy to increase the heart's action. Having previously thoroughly cleansed the skin with soap and water, removed grease with ether or turpentine, and afterwards well sponged it with carbolic lotion (1 in 20) or perchloride of mercury lotion (1 in 500), make an incision in the middle line of the abdomen, midway between the pubes and umbilicus (Fig. 305, a), and having rapidly exposed the peritoneum and stopped all hæmorrhage, carefully open the peritoneal cavity on a director, or with scissors protected by the finger. In cleansing the abdomen great care should be taken to thoroughly disinfect the umbilicus, and the pubic hair should be shaved off. Some surgeons advise that the incision should be limited, and only long enough to at first admit one or two fingers. I prefer, myself, for the purpose of saving time, to make it long enough to at once admit the whole hand if found necessary. If a distended loop presents in the wound the obstruction is probably in the large or lower portion of the small intestine; if this loop contains fluid, fæces, or gas, it is probably

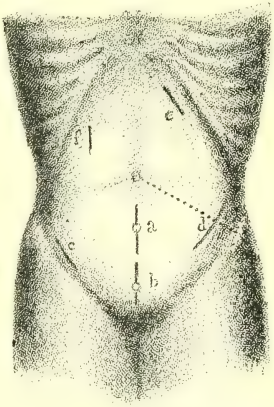

FIG. 305.—Lines of incision in certain operations on the abdomen. a. Laparotomy, Ovariotomy. b. Supra-pubic cystotomy. c. Ligature of external iliac artery. d. Inguinal colotomy. e. Gastrostomy. f. Cholecystotomy.

near the obstruction; if only gas some distance off. Pass one or two fingers or the whole hand into the abdominal cavity and first explore the hernial rings from within, and if these are free the region of the cæcum, taking care to prevent the intestines from protruding by placing over them a warm flat aseptic sponge. If the cæcum is found distended, the obstruction must be in the large intestine. Carry your fingers or hand, therefore, along the course of the colon until the obstruction is met with. If, on the other hand, the cæcum is empty, the obstruction must be in the small intestine. Pass your fingers or hand in this case into the pelvis, and search for an empty loop of intestine below the obstruction and follow the intestine by passing it through the fingers piece by piece till the obstruction is discovered. If after a search of some minutes the obstruction is not found, enlarge the wound and allow the intestines to prolapse, keeping them warm by the continual application of aseptic gauze wrung out of hot water. When the intestines are much distended Mr. Greig Smith advises that the distended loop should be drawn into the wound, punctured with a Spencer Wells ascites needle connected with an aspirator bottle, the distension relieved, and the little wound sutured, the surgeon waiting for hours at the bedside if necessary, and aspirating occasionally till the distension is relieved. The gut in the meantime may be kept in contact with the wound by an aseptic skewer passed under it through the mesentery. In draining the bowel a Paul's tube (Fig. 306) may be used. The gut having been drawn into the wound and packed round with aseptic gauze, an incision large enough to admit the tube should be made, the tube (previously plugged with wool) inserted, and fixed by a ligature passed round the flange. The plug of wool is then removed and rubber tubing fixed to the distal end of the tube to convey away the fæces. After the distension is relieved the case must be treated as circumstances suggest.

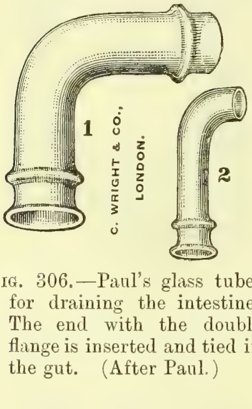

Fig. 306.—Paul's glass tubes for draining the intestine. The end with the double flange is inserted and tied in the gut. (After Paul.)

(*a*) If a loop of intestine is found strangulated in one of the hernial rings, or in a hole in the mesentery, it must be released from within the abdomen, dividing any stricture if necessary. (*b*) If a volvulus is discovered an attempt must be made to untwist it, and as a prophylactic against retwisting, the mesentery may be shortened by folding it upon itself parallel to the intestine and fixing it with sutures. If the volvulus cannot be reduced, the contents may be let out, the wound sutured, and another attempt made. This failing, the volvulus may be excised and the intestine restored by one of the methods of enterorrhaphy (p. 383). If the patient is too collapsed to admit of excision, the volvulus may be left and the intestine short-circuited by means of a Murphy's button or by one of the other methods described at p. 390. If gangrene has occurred, the volvulus must be excised and circular enterorrhaphy or lateral approximation performed. (*c*) If a *band* is met with it must be divided. (*d*) If a *large diverticulum* is the cause of the obstruction it must be cut across and the bowel end closed by Halsted's or Lembert's suture. (*e*) If a *small diverticulum* is producing the constriction it must be severed and the two ends ligatured. Should the intestine give way in dividing the obstructing band, &c., or have already given way—if the perforation is small and the coats are in a fairly healthy condition, the wound in the intestine may be closed by sutures in the way described under Wounds of the Intestine. But if the coats are in an inflamed or sloughy condition, or gangrenous, the diseased portion may be excised, and the upper and lower portions of the intestine united in one or other of the ways already mentioned (p. 383). Only when the patient is much collapsed should the ends of the bowel be fixed to the external wound and an artificial anus made. Before uniting the intestine, however, it may be well in some cases to fix the intestine temporarily in the wound and let the contents of the distended portion drain away for several hours or even days. (*f*) If an *intussusception* is discovered, first squeeze out some of the inflammatory œdema by steady uninterrupted manual compression with an aseptic sponge, and endeavour to reduce the intussusception by gentle traction on the bowel just above the neck of the intussuscipiens and by counter-traction just below the apex of the intussusceptum; or better, try to squeeze out the intussusceptum by kneading and pressure from below. Reduction may possibly be aided by insufflation of the rectum with air or hydrogen. If adhesions have formed, try to break them down by gently insinuating a probe between the contiguous serous surfaces. After reduction search for any rent in the peritoneal coat and bring it together by suture and seal with an omental graft. Reduction failing, the following courses are open:—1. Exclusion of the intussusception by leaving it *in situ* and short-circuiting the intestine (Fig. 307) by forming a communication between the bowel above and below the intussusception by means of Senn's, Murphy's, or some other method. 2. Complete or partial excision of the intussusception and restoration of the bowel by circular enterorrhaphy, lateral approximation, Murphy's button, &c. Complete excision is a most serious operation, especially when a long length of bowel is involved. In such a case if there is no sign of gangrene the sheath may be opened, the intussusceptum excised just below its neck, the stump ligatured, and the continuity of the intestine restored by lateral approximation by button, bone-plates, or simple sutures, or by lateral implantation. When gangrene has occurred, the whole intussusception must be excised. Since the introduction of the more rapid methods of restoring the continuity of the intestine, the need of making an artificial anus should seldom occur.

After any of the above operations, carefully cleanse the abdomen from blood by gentle sponging, and close the wound in the parietes, with the two surfaces of the peritoneum in contact, by sutures passed through the skin and peritoneum. If in spite of all care the peritoneum has been soiled by fæcal matter, or septic changes have already started, flush out the peritoneal cavity with gallons of sterilized hot water, or hot water to which some antiseptic as salicylic acid (5 per cent.) or boracic acid (2 per cent.) has been added. In flushing out, pass the irrigating tube amongst the intestines to the back of the abdominal cavity and into the pelvis so that the water may flow outwards. If the intestines have been allowed to prolapse there may be some difficulty in getting them back. Cover them with antiseptic gauze wrung out of hot water, tucking the margins of the gauze beneath the edges of the wound. Introduce the sutures, and when they are all *in situ* make uniform pressure on the gauze as the sutures are tightened and tied from above downwards. Withdraw the gauze before the last sutures are tied.

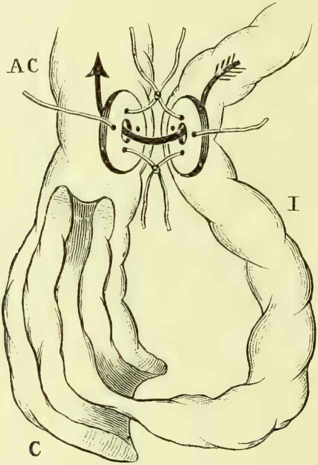

Fig. 307.—Diagram of the method of short-circuiting the intestine for irreducible intussusception. A C. Ascending colon. C. Cæcum. I. Ileum.

Drawing forward the edges of the wound with retractors will materially aid the replacement of the intestines. If they cannot be replaced draw a distended loop away from the wound, aspirate or open it, evacuate as much of the contents as possible, suture the wound by Lembert's method, and again endeavour to replace the prolapsed intestine. When fæcal soiling or septic changes have occurred, place a glass drainage tube in the wound (see *Ovariotomy*), or loosely pack with strips of iodoform gauze or with iodoform gauze rolled up in the shape of a lamp wick, and encircled by a layer of gutta-percha tissue with holes cut in it. The end of the drain should be surrounded by plenty of dry gauze to suck up the fluid.

(*g*) If the obstruction is found to depend on a peri-typhlitic abscess or acute peritonitis a rubber or glass drainage tube, or gauze drain, should be placed in the wound in the abdominal parietes, after the peritoneal cavity has been washed out.

ENTEROTOMY, or NÉLATON'S OPERATION, consists in opening the abdomen by a short incision in the middle line or in the right or left groin, seizing the first piece of distended intestine that presents, and securing it to the wound by sutures and then opening it. This operation is employed in cases where the obstruction is believed to be in the small intestine, though the diagnosis of the situation is uncertain, and where the patient's condition is such that the severe shock and the prolonged manipulation that necessarily attends laparotomy (the operation otherwise indicated) would probably be fatal. It may also be employed in cases of obstruction due to contractions consequent upon the matting together of the small intestines from chronic inflammation, cancer, &c. It should be thoroughly understood, however, that the operation is only intended to relieve the distension of the intestines and prevent their rupture. It does not attack the seat of obstruction. But, by relieving the acute symptoms, it may give time for a diagnosis in doubtful cases to be arrived at; and the patient's condition after it may so far improve as to allow of a more radical course of treatment being undertaken on a future occasion. The method of Greig Smith (p. 622) is likely to replace to a great extent the above operation.

ENTERECTOMY consists in opening the abdomen and excising a portion of the intestine. It may be required for irreducible intussusception, carcinomatous stricture, gangrene from strangulation by bands, the closure of fæcal fistulæ, wounds of the intestine, &c. Open the abdomen as in laparotomy; draw the portion of intestine to be removed well out of the wound, and pack it round with moist antiseptic gauze; clamp the intestine with a rubber tube passed through a small incision in the mesentery above and below to prevent the escape of fæces; cut out the diseased or damaged part;

tie all bleeding vessels; carefully unite the mesentery; and then join the intestine by one of the methods already described (p. 383). Fig. 308 represents a distended cæcum and lower portion of the ascending colon which was removed for carcinomatous stricture by my colleague Mr. Langton. The gut was united above and below the excised portion by Senn's plates, and the patient made an excellent recovery. For the removal of the cæcum the incision should be made in the right iliac fossa.

According to whether small intestine, colon, or cæcum is excised, the operation is spoken of as enterectomy, colectomy, and typhlectomy.

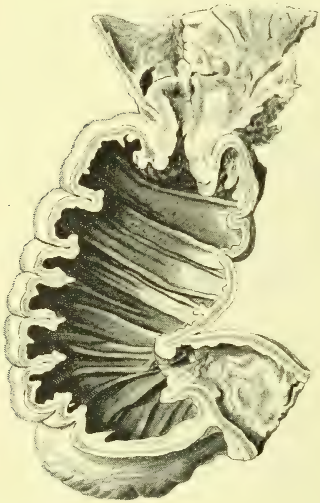

FIG. 308.—The cæcum, with part of the ascending colon and the end of the ileum removed for cancer of the ascending colon. The cæcum was greatly distended. (St. Bartholomew's Hospital Museum.)

INGUINAL COLOTOMY is the operation of opening the sigmoid flexure of the colon in the left groin (*Littré's operation*). It is now almost universally employed in place of lumbar colotomy, especially for carcinoma of the rectum before distension of the colon consequent on the stricture has occurred. Its chief advantages over the lumbar operation are: 1, that there is less difficulty in finding the gut; 2, that there is less danger of peritonitis, in that, as the peritoneum has to be opened, all proper precautions can be taken; 3, that the wound is more superficial, and consequently there is less risk of infiltration of the tissues and septic poisoning; and 4, that the groin is a more convenient situation for an anus than the loin. An oblique incision (Fig. 305, d) about two inches long, is made one inch from the anterior superior iliac spine at right angles to a line drawn from the umbilicus to the iliac spine, one inch of the incision being below and one inch above the line. Divide the skin, superficial and deep fascia, muscles, fascia transversalis, and the peritoneum on a director. If the gut does not present in the wound carefully search for it with the fingers. It may be known by the longitudinal bands of muscular fibres, by the appendices epiploicæ, and by its mesentery running to the left, whereas that of the small intestine runs to the right. Having found the colon, introduce a flat sponge into the wound to prevent the entrance of blood, and stitch the parietal peritoneum to the skin with four sutures. Remove the sponge and draw down the colon until the meso-colon is taut so as to avoid prolapse of the bowel subsequent to the operation. Draw the bowel well into the wound, pass a piece of glass rod beneath it through the meso-colon so as to produce a good spur, and thus prevent the fæces going down the distal end of the intestine, and secure the gut to the parietal peritoneum by sutures passed through only the peritoneal and muscular coats. Apply an antiseptic dressing with a piece of protective next the bowel to prevent its adhering to the gauze, and at the end of three to five days, when adhesions have had time to form, cautiously open the gut by cutting through it on to the glas rod. Some surgeons, for the purpose of forming a spur, draw the gut forward by a ligature passed through the mesentery. Others, with the same aim in view, divide the colon and secure both open ends to the wound; whilst others again close the lower end by means of Lembert's sutures, and drop it back into the peritoneal cavity. These procedures, in my opinion, add to the risks of the operation, and are, I think, unnecessary if the bowel is drawn well into the wound and a piece of glass rod passed through the meso-colon in the way above described. No food should be given by the mouth for the first twelve or twenty-four hours and then slop diet until the gut is opened. If the bowel is greatly distended at the time of operation and threatening to burst, it may be opened at once; or should vomiting and distension come on after the operation, it may be opened before the usual three to five days have elapsed. Some surgeons give opium as a routine practice, others withhold it unless there is pain or restlessness. If the bowel does not act spontaneously after the gut has been opened a gentle saline purge or an enema may later become necessary. The bowel below the wound may also require washing out by an enema.

LUMBAR COLOTOMY is the opening of the colon in the left lumbar region (*Callisen's operation*), or in the right (*Amussat's operation*). They are not often done at the present day. The former is chosen when the disease occurs in the rectum or lower part of the sigmoid flexure; the latter when there is any doubt whether it may not be in the transverse colon. That on the left side need only be described. Place the patient on his right side, slightly inclining towards his face, with pillows under his abdomen, or beneath his loin, in order to make his left side prominent. The outer border of the quadratus lumborum, the guide to the colon, should then be marked: it is situated half an inch posterior to a line drawn vertically upwards from a point midway between the anterior superior and posterior superior spines of the ilium. Then make an incision about four inches long between the last rib and crest of the ilium from the erector spinæ obliquely outwards and downwards. Divide the skin, fascia, and various layers of muscles, viz., the latissimus dorsi, external oblique, internal oblique, and transversalis, and the transversalis fascia on a director (Fig. 309), and the quadratus lumborum will now be exposed at the inner part of the wound, and may be known by its fibres running upwards and inwards. When the colon is distended it will bulge in the wound; when contracted, however, it may be sought in the wound by carefully scratching through the fatty tissue covering it, with two pairs of dissecting forceps. If there is much difficulty in finding it, pass *per rectum* a small catheter, if practicable, through the stricture, and inflate the colon. The colon may be distinguished from the peritoneum, which sometimes presents in the wound, by its situation immediately external to the quadratus lumborum and below the kidney; by the presence of the longitudinal bands of muscular fibres; by the thickness of its coats on nipping it up by the fingers; and, at times, by in this way feeling scybalous masses of fæces in its interior. The peritoneum, on the other hand, may generally be known by the absence of the above characters, and, if it is nipped up, by the intestine being felt to slip away from between the fingers. Having found the colon, secure it to the skin. This is usually done by passing a silk suture by means of a curved needle on a handle, first through the skin, then through the bowel, and then through the skin on the opposite side of the wound, and repeating the procedure at the other end of the wound. The bowel is then opened in a longitudinal direction, the loops of suture by which it is transfixed hooked out by the finger and divided, and the bowel secured to the integument by the four sutures thus formed. A better and more convenient way of passing the sutures, which should then be of wire, is by Smith's cleft-palate needle. If this is used a series of sutures are passed, first through the skin, and then through the wall of the bowel, and tied before the bowel is opened. Should the peritoneal cavity be opened by mistake, it must be carefully closed by suture before the incision is made into the colon.

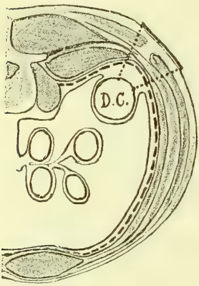

Fig. 309.—Diagram of parts divided in left lumbar colotomy.

Some perform lumbar colotomy in two stages, like gastrostomy; but if the operation is carefully done in the way described above, such is hardly necessary. The bowel beyond the wound may subsequently require clearing with an enema. Indeed, it has been proposed to close completely this part of the bowel by operation so as to prevent fæces passing down it.

OPERATIONS ON THE LIVER, GALL-BLADDER, STOMACH, SPLEEN, AND PANCREAS.

Aspiration of the liver is sometimes performed for the purpose of diagnosis in the case of a suspected hydatid cyst or abscess in the liver, or for the removal of the fluid from an hydatid cyst. Having thoroughly cleansed the skin with an antiseptic and placed the patient, if nervous, under an anæsthetic, introduce the aspirating needle at the most prominent part of the swelling, taking care to avoid the colon and intestines. When operating for hydatids, stop the aspiration if blood escapes, if the patient becomes faint, or if violent cough comes on. Otherwise continue the aspiration till the cyst is emptied. On the removal of the needle place an antiseptic pad over the wound. The operation is not free from danger, several patients having died suddenly on the introduction of the needle, apparently in some cases from plugging of the pulmonary vein by a portion of an hydatid that has escaped into the circulation through a wound of one of the hepatic veins; and general infection of the peritoneal cavity with hydatids has sometimes happened. It is better, therefore, for the purpose of diagnosis, to make an exploratory incision and to evacuate the hydatid cyst or abcess in the way described below.

Incision of the liver may be required for evacuating an hydatid cyst, or abscess. Make an incision over the most prominent part of the swelling, and having divided the abdominal parietes and stopped all bleeding, open the peritoneal cavity. If the liver is adherent to the abdominal walls carefully incise it, first introducing an aspirating needle to determine the situation of the cyst or abscess. If non-adherent the liver should be stitched to the abdominal wall if suppuration has occurred, otherwise the prominent part should be well packed round with sponges so as to cut off the general peritoneal cavity ; an aspirator may then be introduced to determine the situation of the cyst or abscess, and the liver substance incised. Or the opening of the cyst or abscess may be delayed till the liver has become adherent to the parietes. Great care should be taken, if the cyst or abscess is opened at once, to prevent any fluid or pus escaping into the peritoneal cavity, and the strictest antiseptic precautions should of course be observed. In the case of an *hydatid cyst*, after most of the fluid contents have been evacuated by the aspirator, the nozzle of the irrigator may be inserted between the true cyst wall (*endocyst*) and the fibrous capsule (*ectocyst*), when the pressure of the water will detach the true cyst and gradually cause it to extrude from the capsule (*marsupialisation of the cyst*) or the cyst may be opened, the daughter cysts removed, and the lining membrane shelled off the fibrous capsule. If the operation has been done aseptically the wound may now be completely closed, but if the surgeon has any doubt on this head the edges of the wound in the liver had better be sutured to the abdominal wall, and the cavity in the liver drained. If the cyst has suppurated or an abscess is being dealt with, should adhesion not have occurred suture the edges of the wound in the liver to the abdominal walls, and place a drain tube in the wound and apply antiseptic dressings. If the abscess has already ruptured into the peritoneum that cavity should be thoroughly washed out with hot boric acid lotion and drained.

Tapping the abdomen for ascites should be done in the linea alba midway between the umbilicus and the pubes (Fig. 305, a). The bladder having been emptied, a small incision should be made through the skin, and the trocar and cannula, with a tube attached to convey the fluid into a vessel, should be thrust into the abdomen. The fluid should be drawn off slowly, and a many-tailed bandage, previously passed round the body, gradually tightened as the fluid flows, in order to keep up pressure on the abdominal vessels, and so prevent syncope. Or the fluid may be drawn off with a Southey's trocar and cannula. When this is used a skin incision is not necessary, nor is the many-tailed bandage, since the abdomen takes many hours to empty on account of the small size of the cannula, and there is thus no fear of syncope.

Cholecystotomy is the opening and draining of the gall-bladder, consequent upon the impaction of a calculus in the cystic duct. Make a vertical incision in the linea semilunaris, beginning just below the ninth costal cartilage, or over the tumour when the gall-bladder is distended (Fig. 305, f). Having divided the abdominal parietes and stopped all bleeding, open the peritoneum. Search for the gall-bladder with the finger beneath the liver if it does not present in the wound, and bring it to the surface if practicable. Pack the wound with sponges to prevent any fluid escaping into the peritoneal cavity, and introduce an aspirator-needle into the gall-bladder, which, as the fluid escapes, should be well drawn into the wound. Enlarge the opening in the gall-bladder and remove any gall-stones found loose. If a stone is found impacted in the cystic duct, extract it, if possible, by forceps, by gentle manipulation with the fingers in the abdomen, by careful crushing with padded forceps (*choledocho-lithotrity*), by breaking it with a needle passed through the wall of the duct, or by chipping off fragments as it lies in the duct. Secure the edges of the aperture in the gall-bladder to the abdominal wall by sutures, with its peritoneal coat well in contact with the parietal peritoneum; leave a drain-tube in the gall-bladder; and close the rest of the abdominal wound in the way already described. The biliary fistula thus left will generally close in a few weeks if the cystic duct has been cleared.

CHOLECYSTECTOMY, or extirpation of the gall-bladder, may be required: 1, where perforation following suppuration and ulceration has occurred, and the coats are found too softened to admit of suture; and 2, where cholecystotomy is indicated, but on opening the abdomen the gall-bladder is found so contracted that its fundus cannot be drawn into contact with the abdominal walls without tearing it. Make an incision similar to that for cholecystotomy, prolonging it or dividing the muscles transversely a little below the ribs if more room is required. Having well packed the wound with sponges to prevent blood escaping into the general peritoneal cavity, dissect the gall-bladder from the liver, clamping or tying any bleeding vessels, divide the cystic duct between two ligatures, cleanse the wound, remove the sponges, and unite the abdominal walls in the usual way.

Cholecystendysis is the operation of opening the gall-bladder by a small incision, removing any stones that may be present, and then closing the wound by a continuous silk suture, the muscular coat by a second continuous suture and the peritoneal by a Lembert suture. After the proper toilet of the peritoneum has been made, the wound in the parietes is then closed or an aseptic gauze drain inserted. It should only be done for small stones when the walls of the gall-bladder are quite healthy; or for small penetrating wounds or small ruptures of the gall-bladder in the neighbourhood of the fundus. This operation is contra-indicated when there is obstruction in the common bile-duct.

CHOLECYSTO-ENTEROSTOMY, or the establishment of an opening between the gall-bladder and the intestine, may occasionally be required for irremovable obstruction of the common bile-duct, as from cancer about the head of the pancreas, duodenum, &c., involving the duct. Having opened the abdomen as in other operations on the gall-bladder, draw the gall-bladder and duodenum into the wound, and having made an incision into each, unite them by suture, or better, by Murphy's button. When the latter method is employed a running thread is first passed, as shown in Fig. 160, through all the coats of the duodenum, and then another thread in like manner through all the coats of the gall-bladder. An incision is next made into the duodenum within the running thread (see Fig. 160) two-thirds of the length of the diameter of the button to be used, the button slipped in, and the thread tightly tied round the central cylinder (see p. 390). A similar incision is made in the gall-bladder, its contents evacuated, the other half of the button inserted and secured by the running thread in a similar way. The two halves of the button, held by the fingers in the way shown in Fig. 310, are now pressed together, thus fixing the serous surfaces in contact. The spring in the button produces pressure-atrophy of the tissues embraced by it, leaving an opening as large as the button, which, thus freed, is passed *per anum*.

CHOLEDOCHOTOMY or CHOLEDOCHO-LITHOTOMY are the terms applied to removal of a gall-stone impacted in the common bile-duct. Having opened the abdomen the finger follows the gall bladder, cystic duct, and common bile-duct as it lies in the gastro-hepatic omentum and behind the first portion of the duodenum. Passing the finger into the foramen of Winslow will often aid in detecting the calculus. The duct with the gastro-hepatic omentum is drawn into the wound, an incision, parallel to the long axis of the duct, made over the calculus, and the latter removed after first breaking it up, if large, with forceps. The mucous membrane of the duct is united by a fine silk suture, and then the muscular and serous coats. The wound in the parietes is then closed, or a gauze drain inserted.

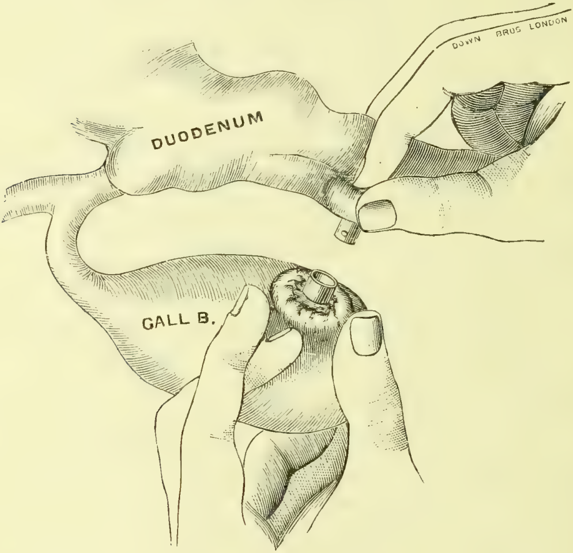

FIG. 310.—Male and female half of Murphy's button, fixed *in situ* and ready for pressing together. (After Murphy.)

CHOLEDOCHOSTOMY or the operation of establishing a cutaneous fistula with the interior of the common bile-duct, has occasionally been employed where there has been great dilatation of the duct as a result of irremovable pressure, as by an abdominal tumour.

CHOLEDOCHO-ENTEROSTOMY, or the operation of forming a fistulous passage between the dilated common bile-duct and the intestine, and CHOLEDOCHECTOMY, or excision of a portion of the common bile-duct for localized malignant growths, &c., have been performed a few times.

PYLORECTOMY, or removing the pylorus for carcinoma, was formerly done by uniting the severed duodenum to the stomach by sutures. Now the cut ends of the stomach and duodenum are usually sewn up by a continuous Lembert suture, and the stomach united to the duodenum or the jejunum by Senn's plates (Fig. 312), Murphy's button, or some other method of lateral approximation.

GASTRO-ENTEROSTOMY, or forming a fistula between the stomach and small intestine to allow fluids to pass out of the stomach, is employed (A) where the disease of the pylorus is too extensive for removal; (B) after excision of the pylorus to save the time required to sew the stomach to the duodenum; and (C) in fibrous stricture of the pylorus leading to dilatation of the stomach (Fig. 311). It may be done by placing one of Senn's plates in the stomach and the other in the termination of the duodenum or commencement of the jejunum, in the way shown in Fig. 312. A reaction, however, seems setting in against the use of Senn's plates, since it is thought by some that they favour regurgitation of the contents of the intestine into the stomach, and that, after their use, there is a tendency for the aperture between the viscera to contract. By Postnikow the jejunum is attached to the front of the stomach by a row of sutures passing only through the serous and muscular coats; then in front of the line of sutures oval portions of the serous coat of each viscus are removed; the exposed muscular coat and

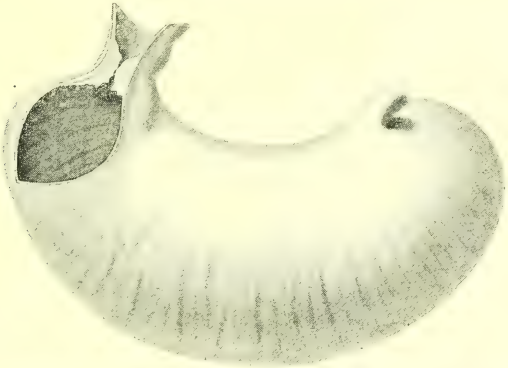

FIG. 311.—Dilatation of the stomach from carcinomatous stricture of the pylorus. The stomach held ten pints. (St. Bartholomew's Hospital Museum, No. 1923 *a*.)

underlying mucosa of each viscus are next pinched up and tightly ligatured so as to cause them to slough, and the raw edges of the serous coats united, each to each, by non-penetrating sutures. Another row of stitches are finally inserted in front.

Duodenostomy and jejunostomy, or the operations for forming an artificial opening into these portions of the small intestine respectively, are so rarely required that they are not here described. Neither is the operation of opening the stomach, securing it to the abdominal walls, and then scraping away with a curette portions of the carcinoma blocking the pylorus. Indeed, gastro-enterostomy by the improved methods has practically replaced these operations. The necessity for the large number of Lembert's sutures formerly employed in gastro-enterostomy is now done away with, and the operation can consequently be performed in a very much shorter time, and hence with much less shock. Many successful cases have been recorded.

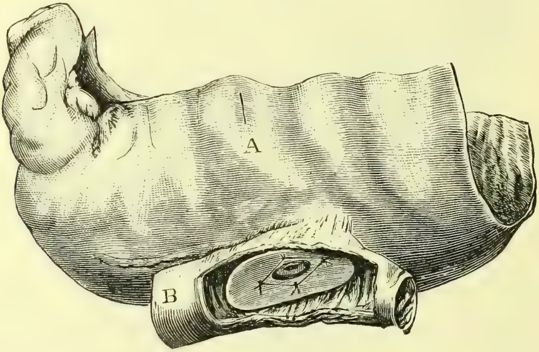

Fig. 312.—Part of the stomach and jejunum from a case of gastro-enterostomy for malignant growth at the pylorus. A. Stomach. B. Jejunum. The bone plates are still *in situ*. The plate in the jejunum is seen. (St. Bartholomew's Hospital Museum.)

Dilatation of the cardiac and pyloric ends of the stomach for simple fibrous stricture (*Loreta's operation*) consists in opening the stomach and then dilating the cardiac or pyloric end, as the case may be, with the finger. The wound in the stomach is then closed by Lembert's suture, and the abdominal parietes united, as after ovariotomy. The strictest antiseptic precautions must of course be taken. In the successful operations there has been no return of the stricture at present.

Pyloroplasty, which has been successfully employed for non-malignant stricture, consists in dividing the pylorus horizontally (Fig. 313), widely retracting the margins of the wound, and then uniting them by suture in such a way as to leave the incision vertical. The steps of the operation are shown in Fig. 313.

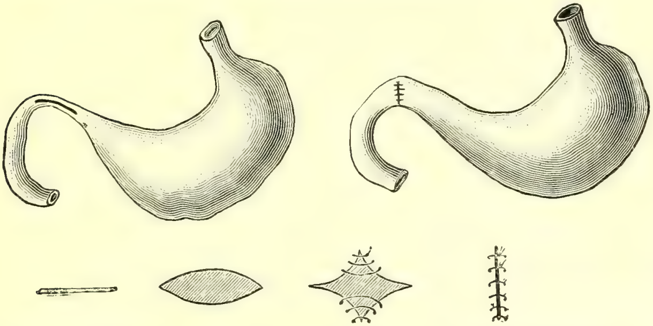

FIG. 313.—Method of performing pyloroplasty, diagrammatically shown. (From Esmarch and Kowalzig.)

SUTURE OF THE STOMACH FOR PERFORATING ULCER has now been frequently undertaken. I have myself operated three times. The indications for surgical interference are, severe collapse and acute pain in the abdomen, coming on suddenly in a patient suffering from symptoms of gastric ulcer. The abdomen should be opened in the middle line above the umbilicus; the perforation, which is usually quite small, clean cut, and situated upon the anterior surface of the stomach, sought; and the peritoneal coats

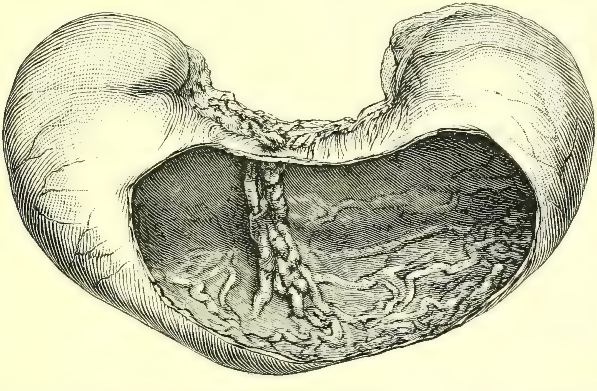

FIG. 314.—A stomach opened to show the puckering of the mucous membrane after suture for perforating ulcer. (St. Bartholomew's Hospital Museum, No. 1918 a^1.)

brought into contact over the perforation by Lembert's sutures. If little soiling of the peritoneum has taken place, the area of extravasation only should be sponged clean and the wound dried, but if extensive extravasation has occurred, the peritoneal cavity should be well flushed out and a gauze drain placed in the wound. Some advise that a portion of the stomach wall around the hole should be excised, and a continuous suture placed in the mucous membrane and a second row of Lembert's sutures in the peritoneal and muscular coats. This, however, is not necessary. In my cases I doubt if suture of the mucous membrane would have been possible (Fig. 314).

SPLENECTOMY, or extirpation of the spleen, may be required for rupture of the viscus, and for some cases of hypertrophy. An incision is made either in the linea alba, the left linea semilunaris, or still further to the left, and the spleen having been thoroughly exposed, adhesions carefully broken down, and the organ, if enlarged, drawn out of the wound, the pedicle is transfixed in several places, and the ligatures interlocked and tied. The pedicle is next severed well to the splenic side of the ligatures, the organ removed, the peritoneum thoroughly cleansed, and the abdominal wound united and drained. Great care should be taken not to tear the splenic substance, an accident attended with fearful hæmorrhage.

DRAINAGE OF PANCREATIC CYSTS due to obstruction of the duct or to injury may be required. These cysts give rise to a tumour in the epigastrium, which is often attended with severe neuralgic pain, and from which may be obtained on aspiration an alkaline fluid having the properties of turning starch into sugar and of emulsifying fats. Fat may be present in the fæces and sugar in the urine. The abdomen should be opened and the cyst stitched to the abdominal wall and drained. Lloyd believes that many of these so-called cysts are due to hæmorrhage into the lesser sac of the peritoneum, the result of injury, whilst Swain attributes them to rupture of a retention-cyst of the pancreas into the lesser sac.

HERNIA.

The term Hernia, though often used in conjunction with other terms to signify the protrusion of any viscus from its containing cavity, as "*Hernia cerebri*," or "*Hernia testis*," when employed alone is applied only to such a protrusion from the abdomen or pelvis, and is equivalent in this sense to the term Rupture, the name by which the affection is popularly known.

DESCRIPTION OF HERNIA IN GENERAL.—A hernia may occur at almost any situation, but is most common at the inguinal and femoral rings, spots at which the abdominal parietes are naturally weaker than elsewhere. It generally consists of intestine, or of omentum, or of both; but almost every one of the abdominal or pelvic viscera have at times formed the protrusion.

THE CAUSES OF HERNIA are predisposing and exciting. *The predisposing* may be divided into: 1. Hereditary and congenital malformations, such as an elongated condition of the mesentery, a patency of the funicular portion of the tunica vaginalis or canal of Nuck, and congenital defects of the abdominal parietes. 2. Acquired elongation or downward displacement of the attachment of the mesentery. 3. A relaxed condition of the abdominal muscles, such as is induced by pregnancy, and by rapid emaciation in persons previously stout. 4. The rapid formation of fat in the omentum or mesentery. 5. Any injury or operation that has weakened the abdominal walls. 6. Occupations involving severe muscular exertion; and 7. The male sex, inasmuch as men are more subject to the exciting causes. *The exciting causes* are such as produce a diminution in the size of the abdominal cavity by the contraction of the muscles forming its walls and the consequent compression of the contained viscera. They may be divided into those that act suddenly, and those that act slowly. Amongst the former may be mentioned sudden and violent exertions, straining at stool, lifting heavy weights, &c. Amongst the latter, continual straining, as from stricture of the urethra, enlarged prostate, phimosis, or a narrow meatus, constant coughing occasioned by chronic bronchitis and emphysema, &c.

ANATOMY OF HERNIA.—As the viscus is protruded through the abdominal or pelvic parietes, whether at one of the so-called rings or elsewhere, it generally forces that portion of the parietal peritoneum, which lies over the aperture, before it in the form of a pouch. When it escapes at the internal inguinal ring, however, instead of thus protruding the peritoneum in front of it, it may pass into the tubular prolongation of peritoneum which naturally descends in front of the testicle in the fœtus, and which from some cause has remained unobliterated. The pouch of peritoneum in which the protruded viscus is thus enclosed is called the sac. In the former case it is spoken of as an *acquired*, in the latter as a *congenital* sac. In some forms of cæcal hernia the sac may be incomplete, *i.e.*, the viscus may be only covered by peritoneum in front, and in contact with the tissues behind; and in diaphragmatic hernia, and in hernia following a wound of the abdominal walls where there is no parietal peritoneum covering the aperture, there will be no sac. The protruded viscus enclosed in its peritoneal sac forms a swelling surrounded by the tissues of the part into which it has escaped. The tissues superficial to it, *i.e.*, between the sac and the skin, form what are called its coverings. We have to consider, therefore, 1, the sac, 2, its contents, and 3, its coverings.

1. The *sac* is said to consist of a body, neck and mouth, terms

which sufficiently explain themselves. It is at first thin and membraneous, resembling the peritoneum; but in old herniæ may become thickened and indurated, or else, as for example in umbilical hernia, attenuated, or in places absorbed. It is usually globular or pyriform, but may take almost any shape. Thus it may be fusiform, hour-glass-like, or divided by adhesions into two parts, the lower part, perhaps, containing fluid and forming what is known as a *hydrocele of the sac* (see *Hydrocele*). The neck is at first generally slightly puckered, but as the result of inflammatory consolidation becomes in old herniæ smooth, thickened, and often indurated. The mouth may be wide and expanded, or, in the case of congenital herniæ, in which the neck is frequently elongated, narrow and contracted.

2. The *contents of the sac* may be intestine alone (*enterocele*); or omentum alone (*epiplocele*); or both, the omentum then generally descending in front of the intestine (*entero-epiplocele*), or more rarely the intestine in front of the omentum (*epiplo-enterocele*). In exceptional instances the bladder, the ovaries, and other of the abdominal or pelvic viscera, have been met with in the sac. The small intestine, and especially a portion of the lower three feet of the ileum, most frequently descends. When the large intestine descends it is generally the cæcum; but any portion of the small or large may do so. There may be but a small knuckle of intestine in the sac, or a part only of its calibre; but when once a portion has escaped there is generally a tendency for more to follow, and in old herniæ to the extent of several inches or even feet. The protruded intestine and mesentery in long-standing cases becomes hypervascular and thickened, and the omentum hypertrophied and matted together. A small quantity of serous fluid is also generally found in the sac, and in rare instances loose or attached fibrinous bodies somewhat similar to those met with in bursæ. Where the neck of the sac has become obliterated by the long wearing of a truss, the sac has been found filled entirely with serous fluid, thus forming a cyst.

3. The *coverings of the sac* necessarily vary according to the situation of the hernia. They will be enumerated under each special form, and little more need be said about them here further than that they often become thickened, blended together, thinned, or absorbed, so that in actual practice they can seldom be demonstrated.

THE CONDITIONS OF A HERNIA.—A hernia may be: (1) reducible; (2) irreducible; (3) strangulated; (4) incarcerated, or (5) inflamed.

1. A REDUCIBLE HERNIA is one that can be returned into the abdominal cavity; *i.e.*, it either goes back when the patient lies down; or it can be made to do so by the patient himself, or by the surgeon making pressure upon it in a suitable direction. The sac,

except perhaps in quite recent cases, cannot be put back into the abdomen in consequence of its adhesions to the surrounding tissues, but remains empty *in situ*.

Symptoms.—At first there may be a mere fulness or protrusion, commonly at one of the abdominal rings; the protrusion becomes more prominent when the patient stands up, strains, or coughs, but it completely disappears on his lying down. If neglected it gradually increases in size, forming a prominent non-translucent swelling, in which a distinct impulse is felt on coughing. If the hernia contains intestine (*enterocele*), it will be tense and elastic, and resonant on percussion; whilst a peculiar gurgling is heard from the displacement of gas and fluid on returning it into the abdomen. If on the contrary it contains omentum (*epiplocele*), it will be dull to percussion, doughy and inelastic, or hard and resisting, and lobulated, whilst the characteristic gurgling is not heard on returning it to the abdomen.

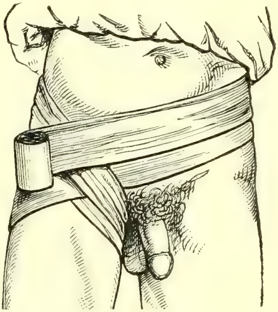

Fig. 315.—Spica bandage for the groin. (Bryant's Surgery.)

The *diagnosis* will be given under the head of *Special Herniæ*, as it is from other diseases of each special region that a diagnosis has to be made.

The *treatment* may be palliative or radical. The *palliative* treatment consists in reducing the hernia and applying some form of truss. A pad and spica bandage should be applied (Fig. 315), till a truss can be procured. The form of truss will vary according to the position, size, &c., of the hernia. Fig. 316 is an inguinal truss of the ordinary shape, and may be distinguished from a femoral (Fig. 317), by the pad of the latter being placed more vertically. Fig. 318 is an umbilical truss. In measuring for a truss the following notes should be taken and sent to the maker:—1. The dimensions round the pelvis, midway between the crest of the ilium and the great trochanter. 2. The kind of hernia. 3. The side on which it is situated. 4. The size of the ring. 5. The age and sex of the patient. 6. The strength of the spring required. The truss should be worn constantly, and never on any excuse be left off. A lighter truss may be provided for the night, and one covered with india-rubber or made of vulcanite for the bath. The *radical* treatment consists in reducing the hernia, and in some way obliterating the sac and closing the canal and ring. In young children the removal of the cause, as phimosis, &c., and the wearing of a truss may do this, but in older children, and in adults, the ring is usually too large and otherwise altered for the hernia to be thus cured, and some further procedure, if thought advisable, must be undertaken.

Radical cure of hernia.—The methods that have been practised for the radical cure of hernia are very numerous. Some of them, as Wood's, Spanton's, Warren's and Heaton's are practically obsolete and will here be no longer described. The more modern methods are all founded to a greater or less extent on Banks' operation, which consists in cutting away the sac after ligature of its neck, and sewing up the ring. This simple procedure, though often sufficient to ensure a radical cure, is sometimes followed by a return of the hernia; hence more elaborate operations have been introduced. Most of them are only applicable to inguinal hernia. Sufficient time has hardly elapsed to enable one to say which of the methods are the most efficient, or to what special form of inguinal hernia the one or the other method may be best adapted. The methods I have employed myself of late are a modified Banks' operation for simple cases, and a modified Bassini's for cases in which the external ring is very large and the canal more or less obliterated.

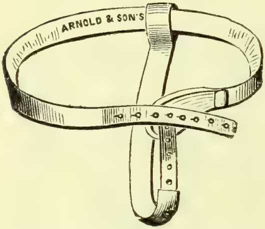

FIG. 316.—Inguinal truss.

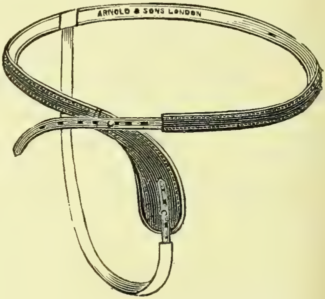

FIG. 317.—Femoral truss.

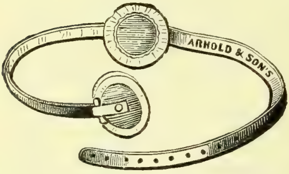

FIG. 318.—Umbilical truss.

(1) *Macewen's method.*—Macewen dissects up the sac and frees it as far as the internal abdominal ring by introducing his finger along the inguinal canal. The internal ring having been reached, the peritoneum is separated for about half an inch from the whole of the abdominal aspect of the circumference of the ring. The external oblique is not divided. A stitch is firmly secured to the distal extremity of the sac and a needle carrying the silk is passed in a proximal direction several times through both layers of

the sac, so that when pulled upon the sac becomes folded upon itself like a curtain (Fig. 319). The needle is then brought out through the anterior abdominal wall just above the internal ring, and the folded sac having been pushed through the ring in the transversalis fascia is secured there by the silk suture. The internal oblique and transversalis muscles are now drawn under Poupart's ligament and there fixed by a catgut suture so as to close the internal ring, the aponeurosis of the external oblique being avoided so that its elastic recoil shall not draw open the canal. The external abdominal ring is then laced up and the skin-incision closed in the usual way.

(2) *Stanmore Bishop's method.*—Stanmore Bishop dissects up the sac and frees it from the surrounding structures as far as, but not beyond, the internal abdominal ring. A long suture, armed at both ends by needles, is now passed from below upwards through each wall of the sac in such a way that, when the ends are pulled upon, the sac is drawn up, not like a curtain as in Macewen's operation, but like a purse (Fig. 320). The neck of the sac is next invaginated on one side before the finger, and the needle belonging to the end of the thread on that side passed though the internal ring and made to pierce the abdominal wall from within outwards (Fig. 321). The same thing is done on the opposite side. When both threads are presenting through the muscular structures (Fig. 321) they are pulled up, the sac being at the same time invaginated before the finger as the threads are drawn upon. The sac is then turned inside out in its passage and becomes fixed as a rounded boss exactly over the internal ring, its peritoneal surface being turned towards the intestine and its first fold on either side being firmly applied to the peritoneum immediately within the ring (Fig. 322). The ends of the thread are now tied firmly, but not tightly, over the ring which with the canal is then further closed by buried catgut sutures, so placed as to draw the superior half of the anterior wall of the canal and internal pillar of the external ring well over in front of the inferior half and external pillar.

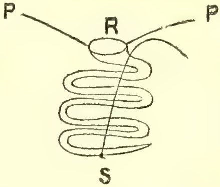

FIG. 319.—Method of folding up the sac in Macewen's method of radical cure of hernia. S. Sac. R. Internal abdominal ring. P P. Parietal peritoneum.

(3) *Barker's method.*—Barker dissects out only the neck of the sac, ligatures it and cuts it through half an inch below the ligature. The scrotal portion of the sac is left *in situ*. The neck of the sac is fixed to the abdominal wall by the same ligature that closes the internal ring. The external abdominal ring is next laced up as usual

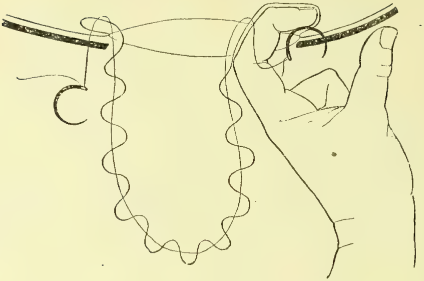

FIG. 320.

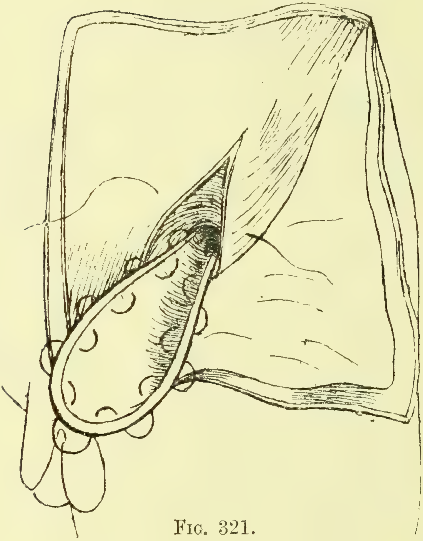

FIG. 321.

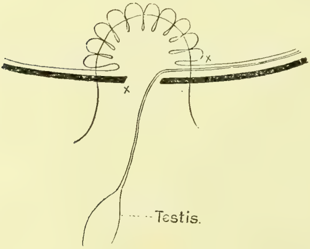

FIG. 322.

FIGS. 320, 321, 322.—Method of treating the sac in Stanmore Bishop's method of radical cure of hernia.

(4) *Ball's method.*—Ball, of Dublin, after dissecting out the sac, recommends torsion or twisting before ligaturing the neck and cutting off the body of the sac. Care must be exercised in applying torsion since the peritoneum has been drawn down and the bladder pulled into the wound.

(5) *Halsted's method.*—Halsted, of Baltimore, makes an incision parallel to Poupart's ligament from the anterior superior spine of the ilium to the pubic spine. He divides the aponeurosis of the external oblique, the whole length of the skin-incision. The sac is then dissected up and sutured by quilted sutures at as high a level as possible and then the lower portion is cut away. The spermatic cord is now transplanted to the outer angle of the wound in the external oblique and the rent in the aponeurosis sutured in its entire extent beneath the cord. In this way the cord takes a subcutaneous course and a new inguinal canal has been fashioned which passes outwards and upwards from the internal abdominal ring.

(6) *McBurney's method.*—McBurney, of New York, treats the wound by open incision after dissecting out and ligaturing the sac. He endeavours to keep the wound an open one by turning in the integument and suturing it to the deep fascia. He then packs it with iodoform gauze and allows the wound to granulate. The wound takes from three to six weeks to heal, but the firm scar left completely obliterates the inguinal canal.

(7) *Bassini's method (slightly modified).*—An incision is made from the internal to the external ring parallel to and about $\frac{3}{4}$-inch above Poupart's ligament. The external ring having been defined the aponeurosis of the external oblique is divided from the apex of the ring the whole length of the skin-incision. The sac is next defined, cleared with the finger as high as the internal ring, the neck ligatured and the body cut away. The cord is now lifted out of the inguinal canal and held aside by a silk ligature passed lightly beneath it (Fig. 323, b). The internal oblique, with the transversalis and transversalis fascia, is next separated from the aponeurosis of the external oblique and from the peritoneum, and sewn by four or five silk sutures to the deep internal surface of Poupart's ligament, which should have been previously defined. In Fig. 323 two of the sutures (D, E) are seen *in situ.* When all the sutures have been passed they are tied beneath the cord and thus pull the conjoined tendon of the internal oblique and transversalis with the transversalis fascia firmly downwards and outwards, and thus form a firm posterior wall to the inguinal canal. The aponeurosis is now united by a continuous suture (Fig. 313, II), and the skin wound closed.

(8) *Radical cure of femoral hernia.*—Make an incision over the hernia from a little above Poupart's ligament vertically downwards about $2\frac{1}{2}$ inches. Having freed the sac, opened it, and returned

its contents, clear the neck with the finger passed up the femoral canal. Ligature the neck ; cut away the body of the sac, and with the aid of Macewen's needles carry the two ends of the ligature, which has been tied round the neck, up the femoral canal anterior to the peritoneum and make them emerge through the abdominal wall just above the round ligament or spermatic cord about a quarter of an inch apart. On tying the two ends of the ligature the sac will be drawn well behind the abdominal parietes. Whilst passing the ligatures protect the femoral vein with the finger, and draw up the skin-incision that the needles may emerge in the wound. On letting go the skin the knot of the ligature will be covered by it. Next sew Hey's ligament to Cooper's ligament (a band of strong ligamentous fibres running along the pectineal ridge of the pubes) by one or two silk sutures, thus closing the femoral canal.

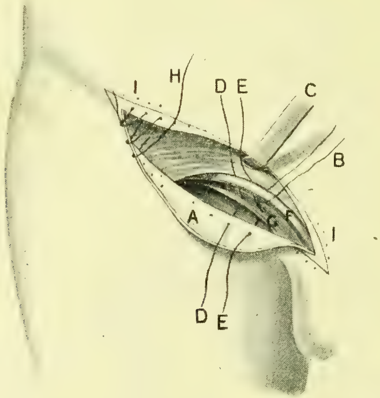

Fig. 323.—Method of applying the sutures in the radical cure of hernia by the modified Bassini Method. A. Aponeurosis of external oblique turned down. B. Silk ligature holding spermatic cord F aside. C. Director retracting the upper margin of the divided aponeurosis of the external oblique. D. and E. Two of the deep sutures passed through the deep internal surface of Poupart's ligament and conjoined tendon. G. The conjoined tendon of the internal oblique and transversalis and transversalis fascia. H. Continuous suture for sewing up the divided aponeurosis of the external oblique. I I. The skin in which some of the spots are indicated at which the skin sutures should be passed.

(9) *The radical cure of umbilical hernia* may be done by excising completely the sac, and the edges of the fibrous ring formed by the linea alba through two semi-circular incisions meeting above and below. The peritoneum, muscles and skin may then be united, layer by layer, by sutures; or if the ring is very

large and its margins are dense, a large flange stitch may be used (Fig. 324), as practised by Greig Smith. The cicatricial tissue is

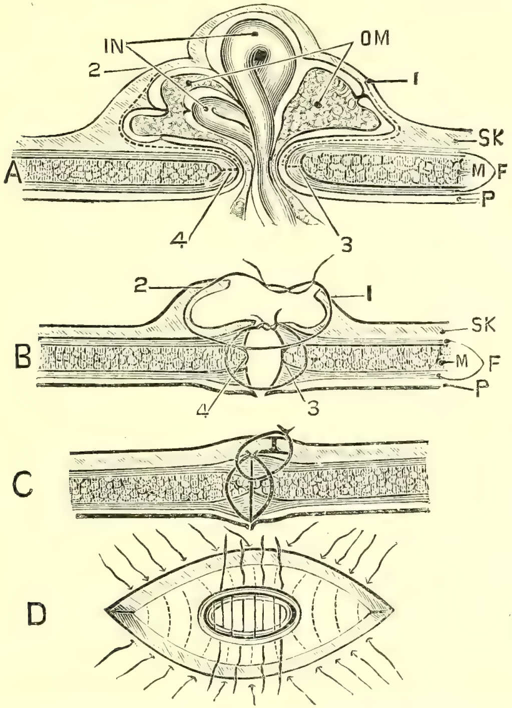

Fig. 324.—Greig Smith's method of performing the radical cure of umbilical hernia. A. Transverse section through hernia and parietes showing sac, contents, ring, and lines of incision. I N. Intestine. O M. Omentum. S K. Skin. F. Fascia, thickened at margin of ring. M. Rectus muscle. P. Peritoneum. 1. Incision through skin of sac, which is continued along the subperitoneal tissue to margin of ring. 2. Same on opposite side. Between 1 and 2, skin and sac are removed on free surface, and sac on deep aspect. 3 and 4. Incisions carried deeply through thickened fascia round umbilical ring to expose recti. B. Gut returned, omentum removed, superfluous skin and sac removed, sutures placed, incisions in fascia opened up and recti exposed. References same as in A. C. Sutures tied, skin suture to one side of parietal line of junction. D. Bird's-eye view showing double set of sutures round umbilical ring and cutaneous wound. (From a drawing by Mr. Greig Smith.)

divided all round the ring at its free margin down to the rectus muscle, and the sutures passed first through the upper fibrous edge, then through the rectus, then through the lower fibrous edge on one side of the wound, and then in the reverse order through the tissues on the other side.

2. An irreducible hernia is one that cannot be returned into the abdomen.

The *causes* of the irreducibility, which are many, may be conveniently classified according as the impediment to the return of the contents of the sac exists:—1. *Outside the sac*, from inflammatory thickening and contraction of the tissues forming the ring or other aperture through which the hernia has escaped. 2. *In the sac walls*, from inflammatory thickening and contraction, and from elongation of the neck of the sac. 3. *Inside the sac*, from (*a*), the great bulk of the intestine or omentum due to increased growth subsequent to their descent; (*b*), constriction of the omentum at the situation of the ring and expansion of the lower part; (*c*), adhesion of the intestine or omentum to the sac, or to one another; (*d*), bands of adhesions stretching across the sac and so confining a loop of intestine or knuckle of omentum; (*e*), a collection of fluid in the sac; (*f*), a portion of intestine (as the cæcum) having descended uncovered with peritoneum on one aspect, the uncovered portion forming adhesions with the tissues around it where the sac is absent.

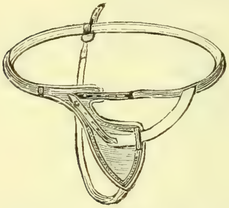

Fig. 325.—Bag truss for irreducible hernia.

The *symptoms* are similar to those of the reducible form, save that the hernia cannot be completely reduced. Thus, there is impulse on coughing, non-translucency, and, when it contains intestine, gurgling on handling, and resonance on percussion. It is, moreover, often attended with dragging or colicky pains and dyspeptic symptoms. When its contents are both intestine and omentum, the intestine can sometimes be returned. A consideration of the above signs should serve to distinguish it from a hydrocele extending high up the cord with which it is perhaps most likely to be confounded. An irreducible hernia often attains a large size, and is not only on this account a constant source of annoyance to the patient, but is also one of danger as there is always a risk of its becoming obstructed, strangulated, or inflamed, or ruptured by accidental blows, &c. The *treatment* may be directed to one of two ends:—1, to protect the hernia from injury and prevent it from getting bigger by the descent of more intestine or omentum; and 2, if possible, to render it reducible, or better, if the patient's general state of health is favourable, to cure it, by one of the radical operations already described. For the first purpose the patient should wear a bag truss (Fig. 325), or the lace-up truss. Trusses are often difficult to adjust. Under such circumstances a cast of the parts should be taken in plaster of Paris, and to this any instrument-maker can then accurately mould the truss. When the patient will submit, an attempt may be made to convert the hernia into a reducible one; and if persevered in will frequently, especially in recent herniæ, be successful. The patient should maintain the horizontal position, the diet should be restricted, saline purgatives given, and ice occasionally applied to the part, or continuous pressure may be kept on the hernia by means of the hinge-cup truss.

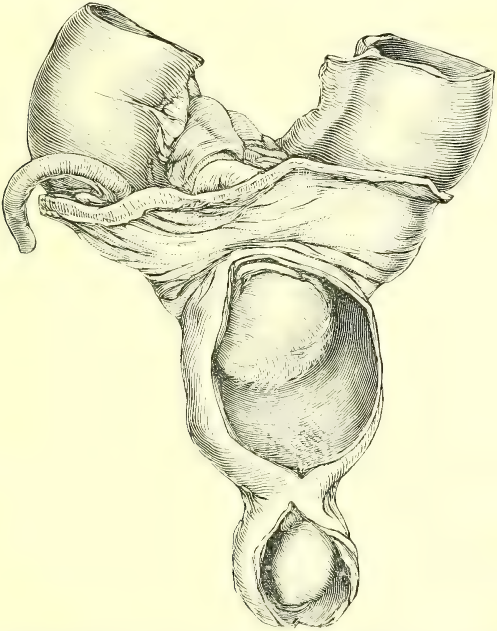

Fig. 326.—Strangulated funicular hernia from a child aged six months. (St. Bartholomew's Hospital Museum, No. 2,140 *g.*)

This treatment, will, of course, only be successful when the irreducibility depends upon removable causes, such as an increase in the bulk of the omentum or intestine. When due to adhesions and the like, it cannot be thus overcome, though with the use of the hinge-cup truss, adhesions, if not too firm, may gradually elongate and disappear. Seeing, however, that strangulation may occur notwithstanding the use of a truss, other things being equal, I always myself advise a radical cure.

3. Strangulated hernia.—This form of hernia (Fig. 326) is one in which the protruded portion of intestine or omentum is so

tightly gripped, that not only is its return into the abdomen prevented, but the circulation through its blood-vessels is so impeded, that congestion, followed by inflammation and gangrene, speedily ensues if the strangulation is not soon relieved.

Causes.—1. The sudden forcing of intestine or omentum through a ring or aperture so small that it is tightly gripped from the moment of its descent. This is usually the cause of strangulation in a recent hernia or in an old hernia which has suddenly descended through the patient's neglect to put on his truss. 2. The increase of bulk in the hernia subsequent to its descent, and its consequent constriction where it passes through the aperture or ring. This is usually the cause of strangulation in irreducible herniæ, or in herniæ that have not been kept up by a truss. Such an increase in bulk may be induced by: (*a*), the sudden protrusion of a fresh portion of omentum or intestine on the top of that already down; (*b*), the swelling of the intestine from catarrhal inflammation of the mucous membrane, or from its becoming obstructed by fæces or flatus; and (*c*), congestion and inflammation of the omentum.

The *seat of constriction*, or as it is technically called the *stricture*, is generally either (1), *outside the sac*, *i.e.*, at one of the tendinous rings, or other aperture through which the hernia has passed; or (2), *in the neck of the sac itself;* whilst (3), in very rare instances, it may be *inside the sac*, the intestine having slipped through a hole in the omentum, or become entangled by a band of adhesions.

Mechanism of strangulation.—The compression of the veins at the seat of stricture impedes the return of venous blood from the protruding portion of intestine or omentum, and the congestion, causing compression of the arteries, ultimately leads to the complete arrest of the circulation, and gangrene finally ensues. The congestion, moreover, induces paralysis of the muscular coat and consequent cessation of its peristaltic action and the onward flow of the intestinal contents. For strangulation to occur it is not necessary for the whole circumference of the bowel to be included in the stricture. An inclusion of only a small portion of its circumference (*Richter's hernia*, sometimes incorrectly called *Littre's hernia*), in consequence of the venous congestion and subsequent inflammation which it induces, is sufficient. Indeed, symptoms of strangulation are said to occur when omentum only is contained in the hernia, a fact somewhat difficult to explain, as constriction of omentum by a tight ligature certainly gives rise to no symptoms. It is possible that in these cases the signs of strangulation have depended on reflex irritation of the omental nerves, or on a small knuckle of intestine having been strangulated at the neck of the sac and slipped back unperceived. That strangulation may produce a severe impression on the nerves, is evidenced by the pain reflected to the umbilicus, and by the general nervous symptoms, *Pathological condition of the strangulated part.*—When the constriction is very tight, the circulation may be completely arrested, and gangrene ensue in a few hours. But as a rule the arrest is only partial, and the gangrene is preceded by congestion and inflammation. The intestine at first appears red and, perhaps, slightly swollen, but not otherwise altered; whilst clear serous fluid in greater or less quantity is poured out between it and the sac. It next assumes a mulberry colour, and as the congestion increases it becomes darker and darker, and finally black or ash-grey. At the same time it becomes more swollen, and loses its bright shining appearance, becoming sticky, then doughy in consistency, and pitting on pressure, whilst the fluid gets darker and turbid, and feculent in odour; finally the intestine sloughs, and its contents are extravasated into the sac. Sloughing or ulceration frequently begins at the seat of stricture, and in the mucous coat, where, even at an early stage, an impression of the stricture is often seen. The omentum undergoes similar changes, passing gradually into a state of gangrene. The intestine, above the strangulated portion for a variable distance, is congested and distended with fæcal matter, whilst that below is empty and contracted but otherwise natural. Simultaneously with these changes a local peritonitis is set up about the neck of the sac, gluing the intestine to the peritoneum, so that as a rule there is no extravasation into the peritoneal cavity. The sac becomes inflamed, a fæcal abscess is formed, and, if the patient survives, opens on the surface, leaving him with a fæcal fistula. In other cases general peritonitis supervenes, or the intestine gives way above the stricture and so peritonitis results.

The *symptoms* are local and general. *Local symptoms.*—The hernia, if previously reducible, is no longer so; it becomes tender or painful on handling, tense, and often tympanitic; and the *impulse on coughing* is lost. Pain may be present in the hernia, but is generally referred to the region of the umbilicus. The skin is usually natural, but where gangrene has occurred, it may become mottled, or brick-dust red, and emphysematous, and exhale a fæcal odour. Cessation of pain may then occur, but is a delusive sign. The *general symptoms* are those of intestinal obstruction, the two chief being vomiting and constipation. The vomiting is of a peculiar gushing character, with little or no retching. The vomit at first consists of the contents of the stomach, but soon becomes bile-stained, and finally fæcal, *i.e.*, thin and brownish-yellow, with a distinct odour of fæces. The constipation is *complete* (except in Richter's hernia), flatus not even passing, although at first the contents of the large intestine may be voided, either naturally or after an enema. The face becomes pinched and anxious, the pulse small and wiry, the tongue furred and brown, and if strangulation is not relieved, the patient may die of collapse, general peritonitis, or exhaustion from constant vomiting. Very occasionally a fæcal abscess may form and the patient recover with a fæcal fistula. Space will not permit of a description of the variations in the symptoms that may be met with, and it must suffice to say that as a rule in young patients with recent hernia they are more acute, and call more imperatively for immediate relief than in older patients, the subjects of irreducible hernia of long standing, in whom they assume a more chronic character.

Treatment.—It cannot be too strongly impressed on the mind of the student that it is of vital importance to release the strangulated intestine; that this as a rule admits of no delay; that every hour adds to the danger (gangrene may occur within twenty-four hours); that the result of the case will depend to a great extent upon the length of time the strangulation has existed; that purgatives for overcoming the obstruction are not only useless but absolutely injurious; and that prolonged and forcible attempts to return the bowel by the taxis are unjustifiable and wholly to be condemned. What should be done, therefore, in a case of strangulated hernia? The taxis should as a rule be applied for a few minutes; if this is unsuccessful the patient may in some forms of inguinal hernia be put in a warm bath for twenty minutes, and another attempt then made to return the bowel. This failing, he should be placed under an anæsthetic, and should the bowel then not slip back readily on again gently trying the taxis, the operation for dividing the stricture should *at once* be proceeded with before he is allowed to recover from the anæsthetic. If the surgeon is not prepared for the operation, or requires help, a full dose of opium should in the meantime be given, and ice, if at hand, or warmth in the form of a large poultice, be applied to the tumour. But it is better not to attempt the reduction under an anæsthetic till prepared to proceed with the operation. We have then to consider the method of applying the taxis, the cases in which it should not be used, the cases suitable for the hot bath, and the operation of herniotomy.

The taxis.—The method of applying the taxis, which is merely the technical term given to the various manipulations of traction and compression used in returning the hernia into the abdomen, can only be learned by practice. The pelvis should be slightly raised, and the thigh, in femoral hernia, flexed and adducted so as to relax as much as possible the constricting ring. With one hand, slightly raise the hernia, and grasp it gently so that some of the flatus or fluid may be squeezed out and the bulk lessened. With the finger and thumb of the other hand, gently compress the neck laterally to prevent its bulging over the margin of the ring, and at the same time draw the hernia a little downwards to disengage its neck. The pressure should be applied steadily, not spasmodically, and its direction varied according to the kind of hernia. No violence should be used, and if after a few minutes the intestine does not slip back with the characteristic rush, further attempts should not be made. Violent or prolonged efforts are strongly to be condemned, as not only are they unlikely to be successful, but may lead to the rupture of the intestine, or stopping short of this may cause so much bruising, ecchymosis, or inflammation, that they jeopardize its recovery after operation. How long should the taxis be applied? Certainly not more than ten minutes at the outside. The length of time, however, may vary in different herniæ. Roughly it may be given at about two minutes for a small tight femoral hernia, and five minutes for a large femoral, inguinal, or umbilical hernia. It should be remembered that the taxis is more successful in recent than in old femoral herniæ; in inguinal than in femoral, and especially in old inguinal under chloroform; and that when successful it is the safest method of overcoming the strangulation. The taxis should not be applied—1, when other surgeons have already employed it for long periods; 2, when the hernia is very tense, tender, or inflamed; 3, in femoral hernia where fæcal vomiting has existed for some time, or where hiccough has supervened;—in short, whenever it appears questionable whether the intestine has not passed into a condition beyond recovery, or whether actual gangrene has not taken place.

The *hot bath* is more likely to succeed in acute than in chronic cases, in young muscular patients, and in inguinal herniæ. It should not, as a rule, be given to the old or feeble, as it has then a tendency to induce severe syncope, and renders them liable to take cold. Little can be expected from it in femoral hernia on account of the fibrous and unyielding nature of the ring.

The operation.—Herniotomy or kelotomy has for its object—1, the liberation of the strangulated intestine or omentum by dividing the stricture, and 2, the returning it into the abdomen if proper or possible. The parts having been shaved and thoroughly cleansed with soap and water and sponged with some antiseptic lotion, an incision should be made over the neck of the sac in the long axis of the tumour, and its coverings carefully and successively divided till the sac is exposed, any bleeding vessels being tied. The sac may be known by the arborescent arrangement of its vessels, its tenseness and smoothness, and, when thin, by intestine, omentum, or fluid being seen through it. It may further be distinguished from the intestine by the shining appearance of the latter, by the circular arrangement of the intestinal vessels, and by a little fluid usually escaping when the sac is opened. If still in doubt, the questionable structure should be picked up with the thumb and fore-finger if not too tense, when, if it is sac, the intestine will be felt to slip away. Before opening the sac, every antiseptic precaution in the widest sense of the term should be taken. All bleeding should be stopped, and the wound, the surgeon's hands and those of his assistant, and the instruments, should be thoroughly cleansed from blood with antiseptic lotion. A piece of the sac should be nipped up with the forceps, and nicked with the blade of the knife held on the flat. If too tense to allow of this, it must be cautiously scratched through with the point of the knife. As a rule there is no danger of injuring the intestine, as some fluid generally exists between the sac and its contents. The sac, however, should always be opened with care, as the intestine may be in contact with it. If omentum is seen shining through the sac, it should be opened opposite that spot. The character of the fluid which escapes is a good criterion of the condition of the parts. If pale and serous, the indication is good; if blood-stained and turbid or fæcal in odour, bad. A director should now be passed through the small opening, and the sac laid open, the fluid absorbed by sponges to prevent it running into the abdomen, and the contents examined. If only omentum presents, this should be gently unravelled to search for intestine, a small knuckle of which will often be found near the neck of the sac. The questions will now arise, what shall be done with the intestine, what with the omentum? Shall they, or can they be returned? Shall the omentum be cut off? Shall the stricture be divided?

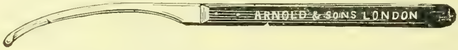

Fig. 327.—Cooper's hernia knife.

Treatment of the intestine.—If the intestine is merely congested and claret-coloured but still shining and the fluid in the sac is of a serous character, there can be no question of replacing it in the abdomen; or if it is already gangrenous (a condition that may be known by its ash-grey colour, loss of elasticity and not bleeding if pricked), there can be no question, on the other hand, that it ought not to be returned, but must be dealt with in one of the ways to be presently described. Again, if it is adherent to the sac the adhesions when soft and recent may be gently broken down with the finger and the intestine returned unless such is contra-indicated from other causes; or when the adhesions are old and fibrous, they may be cut through and ligatured, and the intestine also returned; but when they are thick and fleshy, the intestine may either be left in the sac, as any attempt to break them down would probably lead to the tearing of its walls, or the adherent portions of the sac may be separated from the surrounding tissues and returned with the intestine. In cases of the above kind the treatment is clear; but when the intestine is black, ecchymosed, doughy, sticky, or coated with lymph, but not actually gangrenous, whilst the impression of the stricture is well marked, and the fluid in the sac is of a dark colour, it becomes an anxious moment for the surgeon to decide what to do with it, and much must be left to his own judgment in each individual case. As a general rule it may be said that when only a small knuckle of intestine is present and, although black, has not lost its shining colour, and on gently drawing it down there is no sign of ulceration at the seat of stricture, it should be replaced just within the ring, so that if it subsequently gives way the fæcal contents may escape externally; but that, when the intestine is ecchymosed, doughy, &c., or it is feared that ulceration of the mucous coat may have already begun at the seat of stricture, and especially when a large coil is present, it should be left in the sac, or dealt with in one of the ways to be presently mentioned. Some surgeons, however, if in doubt, always leave the intestine in the sac; others stitch the bowel to the parietal peritoneum, so as to leave the most doubtful part in the centre of the ring of sutures. If the gut gives way the fæces will then pass outwards; if the injured part recovers, the gut will merely be left adherent by one surface to the inside of the abdominal wall. Others again establish a lateral anastomosis between the gut above and below, and should the exposed loop turn out to be gangrenous, remove it the next day and close the ends of the bowel by Lembert sutures.

When the gut is clearly *gangrenous* several courses are open:—

1. An artificial anus may be made (*a*) by merely leaving the gangrenous gut in the sac; or (*b*) by cutting away the gangrenous part; or (*c*) by cutting it away and stitching the open ends of the intestines to the wound. A secondary operation will subsequently be required to close the artificial anus (p. 659).

2. The gangrenous part may be cut away; and the intestine above and below united and returned into the abdomen. When this course is selected some surgeons are in favour of uniting the gut in the wound; others through an incision in the middle line or linea semilunaris. When the mesentery is sufficiently long to allow of the intestine being drawn down, the wound is, perhaps, the better situation. When the intestine cannot be drawn down as in some cases of femoral hernia, then the abdominal incision is preferable. In inguinal hernia the wound can be readily prolonged into the abdominal cavity. In femoral hernia to do this would involve the division of Poupart's ligament and the subsequent weakening of the abdominal wall in this situation. Whichever method is chosen sufficient intestine should be cut away to ensure sound tissues being brought into contact. The peritoneal cavity being protected by aseptic gauze packed round the loop of intestine to be dealt with, cut the gangrenous portion completely away; empty the distended portion above as much as possible; clamp both the upper and lower portions with rubber tubing passed

through a small incision in the mesentery to prevent further fæcal soiling; irrigate with perchloride of mercury (1 in 2,000); restore the continuity of the gut by one of the methods described at p. 383, and replace the united intestine in the abdominal cavity. Remove the sac after ligature of its neck, and close the ring or the abdominal wound in the ordinary way if the operation has been done by the intra-abdominal method.

The choice of establishing an artificial anus, or of excising the gangrenous portion and uniting the gut above and below, will depend in great measure on the general condition of the patient, and on what assistance and appliances for an aseptic operation are at hand.

Should the intestine be accidentally wounded either in opening the sac, or, as more commonly happens, in dividing the stricture, the edges of the wound should be united in the way described at p. 383.

Treatment of omentum.—When small in amount, recently protruded, and only slightly congested, the omentum should be returned. When large in amount, thickened, inflamed, or gangrenous, it should be ligatured, cut off, and the stump returned into the abdomen. Aseptic silk is the best material for ligaturing the omentum. The ligature, to prevent slipping, should be tied very tightly or made to transfix the pedicle, the latter, if necessary, being gently pulled down to ensure its being tied at a healthy spot. When the omentum forms a large mass it should be carefully unravelled to determine the absence of intestine in its midst, and then tied in separate portions. Ligature of the vessels separately is unsafe, as some may be missed, and hæmorrhage occur into the peritoneal cavity. The ligatures should be cut off short and returned with the omentum. They become encysted and cause no irritation. If the omentum is adherent to the intestine it may be gently separated from it or returned with the intestine. If adherent to the sac it may be separated and returned or removed with the latter.

Division of the stricture at the neck of the sac.—Pass the index finger gently between the intestine and the sac, or if the omentum is spread out between the intestine and the sac (forming the so-called *omental sac*), between the intestine and omentum. The stricture having been discovered, insinuate the finger-nail gently under it, and the intestine being held aside by the other fingers or by an assistant, pass the hernia knife, held with its blade on the flat and protected by the pulp of the finger, beneath the stricture, turn its cutting edge towards the stricture, and notch the latter in one or more places by gently depressing the handle. The direction in which the notch should be made will depend upon the situation of the hernia; in extent it should be as limited as possible. The surgeon, as a rule, will do better to employ his finger than the director, as there is much less risk of wounding the intestine, but if a director is used it should be broad and flat so as to prevent as much as possible the intestine bulging over it, and so coming into contact with the edge of the knife (Fig. 328). If it is found that the stricture is not sufficiently divided to allow the intestine to slip back on being manipulated with the fingers, a second notch should be made. But if the intestine does not then return easily the stricture should be divided again, as no force must be used. Instead of dividing the stricture from within outwards, in inguinal hernia the incision may be made over the internal ring, and the stricture then divided from without inwards. Every step is plainly in view, and no hernia knife or director is required.

Where the intestine is gangrenous, some surgeons, who hold that it is better to leave the gangrenous intestine in the sac, merely notch the stricture, disturbing as little as possible the adhesions that have formed between the intestine and the neck of the sac, as it is upon these cutting off, as they do, the general peritoneal cavity from the gangrenous gut, that the patient's safety depends. If this course is pursued the stricture had better be divided from without inwards, so that neither the finger nor the director need be pushed up from the septic sac into the abdomen. If the ring is thus treated the peritoneal adhesions may be left undisturbed. The division here is not practised for the purpose of relieving the strangulation, as the bowel is already dead; but for the purpose of allowing the contents of the bowel above the gangrenous part to escape externally.

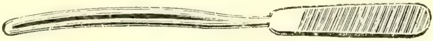
Fig. 328.—Wormald's hernia director.

Treatment of the sac.—The next question that arises is, what should be done with the sac? My own practice has been, unless otherwise contra-indicated, to dissect up the sac, apply a silk or stout catgut ligature to its neck, and cut the body of the sac away. In *inguinal* hernia the ring may then be brought together with sutures, and the wound closed. In *femoral* hernia the parts are so rigid that they are with more difficulty brought together. In *umbilical* hernia the sac with the redundant integuments may be removed, and the wound united with the peritoneal surfaces in contact by deep and superficial sutures. Some, however, still prefer simply to leave the sac *in situ*, merely uniting the wound, and applying a pad. The sac should not be ligatured and cut off:—1. When the patient is weak or collapsed, and it is desirable to complete the operation with as little delay as possible. 2. When the intestine is in that doubtful condition that it has only been placed just within the ring. 3. When the abdomen contains much serous fluid, or peritonitis is present—a gauze drain or tube may then be inserted.

After-treatment.—The wound should be dressed antiseptically, and a spica bandage firmly applied. Half a grain of morphia may then be injected subcutaneously, or a full dose of opium given by the mouth. Some surgeons keep the patient subsequently under the influence of the drug, in order to place the intestine at rest till it has had time to recover from the effects of the inflammation; others only employ it if there is pain or restlessness. To further insure rest some wash out the stomach with the stomach-pump. With the same end in view no nourishment should be given by the mouth for the first twelve or twenty-four hours, but teaspoonfuls of hot water may be given occasionally to relieve thirst and check any tendency to vomit. Nutrient suppositories or nutrient enemata after the first twelve hours may be given by the rectum. Subsequently milk, in small quantities at a time, may be taken by the mouth, then, in addition, beef-tea; but no solid food should be allowed till the bowels have acted. This they should usually be permitted to do spontaneously, as no harm will ensue should they continue confined for a week or ten days. If, however, any distension or uncomfortable sensations are experienced, an enema of soap and water may be given on the second or third day, or the rectal tube passed to permit of the escape of flatus, and a change of position in bed allowed. If the distension is great a purge on the third day may sometimes with advantage be given; such, however, in my experience is seldom required.

Conditions that may give rise to a continuance of the symptoms of strangulation after the taxis or herniotomy.—As a rule the symptoms of strangulation cease immediately or soon after the successful application of the taxis, or of herniotomy. Should they persist they may depend on—1. The effect of the anæsthetic. 2. Paralysis of the muscular coat of the intestine. 3. The presence of another hernia. 4. The displacement of the hernia, or reduction *en masse*. 5. Detachment of the neck of the sac, the intestine remaining strangulated. 6. Rupture of the sac, and reduction of the intestine through the rent, the strangulation continuing at the neck. 7. Passage of the intestine into a pouch or second sac instead of into the abdominal cavity. 8. Incomplete reduction of the intestine. 9. The gut becoming gangrenous and giving way. 10. Enteritis or peritonitis. 11. Internal strangulation of the intestine by adhesion probably near the neck of the sac.

If the persistence of the symptoms is due to the anæsthetic they will usually pass off in a few hours. The vomiting, moreover, is usually attended with much retching, and is not of that gushing nature characteristic of strangulation of the bowel. If due to paralysis of the muscular coat of the intestine, the symptoms will also, as a rule, gradually cease as the congestion passes off. Should they not do so, however, a careful search should be made, if this has not already been done, for another hernia, and if one is discovered and appears strangulated, it should be explored. If no other hernia exists the continuance of the symptoms may be due to the hernia not having been properly reduced, to peritonitis, to the persistence of the paralysis of the muscular coat of the gut, or to internal strangulation. If, therefore, the hernia is reported not to have slipped back with the usual gurgle, or there is some fulness felt about the hernial ring, the ring must be cut down upon and explored, or the wound, if an operation has been performed, opened up. It may then be found (*a*) that the hernia has been reduced *en masse, i.e.*, that the hernia, along with the sac, has been forced between the fascia transversalis and the peritoneum, a condition most frequently met with when the hernia is femoral; (*b*) that the neck of the sac has become detached, the intestine remaining strangulated; (*c*) that the posterior part of the sac has been rent and the hernia, still strangulated at the neck, forced into the subserous connective tissue; or (*d*) that the hernia has passed into a pouch at the neck of the sac instead of into the peritoneal cavity; (*e*) that the intestine has not been completely reduced. Under any of the above circumstances the finger should be introduced into the sac. If it *can* be passed through the neck into the abdominal cavity the continuance of the symptoms will probably depend on (1) paralysis of the muscular coat consequent on injury of the intestine; (2) reduction into a pouch at neck of sac; or (3) strangulation by adhesion within the abdomen. In such cases the portion of intestine at fault will probably be in the near vicinity of the neck of the sac, and can be drawn down by the finger and inspected. If, on the other hand, the finger *cannot* be passed into the abdominal cavity the trouble will most likely depend upon (1) a reduction *en masse*; (2) detachment of the neck; (3) a rent of the sac; or (4) incomplete reduction. Try to feel the neck of the sac with the finger. If this cannot be felt then the neck of the sac has been detached and pushed backwards, and the condition is one of reduction *en masse*. If the neck can be felt, but there is no passage into the abdomen, then the contents of the sac have probably been forced through a rent in the sac into the surrounding tissues. The sac should then be drawn down, the condition causing the strangulation accurately ascertained, the stricture, wherever situated, divided, and the intestine returned into the peritoneal cavity. Peritonitis following the reduction of a hernia may be known by the signs already given at p. 395, and should be treated as there indicated. Persistent paralysis of the muscular coat, or the existence of internal strangulation, may be suspected when along with the continuance of the symptoms of strangulation of the bowel the signs of the other conditions that may give rise to such symptoms are absent. Should the paralysis not pass off under the influence of time, an enema, or even a purgative, may, in some cases, be useful to rouse the intestine to action, whilst, in rare instances, it may become necessary to explore the abdomen, open the intestine above the paralysed part, and suture it to the wound in the parietes. Internal strangulation should be treated as described under *Laparotomy*.

Prognosis.—The prognosis in a case of strangulated hernia will depend on the length of time the hernia has been strangulated, the tightness of the stricture, the presence or absence of gangrene or peritonitis before the operation, the amount of bruising inflicted on the gut by the taxis, the degree of exposure and manipulation to which the gut is subjected during the operation, and the general condition of the patient. Moreover, the prognosis is graver in a small femoral hernia, and in a hernia which has recently come down (inasmuch as in these the constriction is usually tight), than in an oblique inguinal hernia, or a hernia of long standing, in which the constriction is usually much less.

4. OBSTRUCTED OR INCARCERATED HERNIA.—These terms are generally applied synonymously to an irreducible hernia in which the protruded intestine has become obstructed by a collection of undigested food, foreign bodies, as fruit-stones, &c. The hernia is most frequently met with in old people, and if neglected, is apt to become strangulated or inflamed. *Symptoms.*—As in strangulation, there may be constipation, colicky pains, nausea, and perhaps vomiting; but the local signs of strangulation are less marked. Thus, there may be little or no local pain and no tension in the sac, though, at times, it may become distended and larger than before the incarceration occurred. The impulse on cough may still be present, and hard fæcal masses may, perhaps, be felt. The symptoms, however, may gradually merge into those of strangulation, and it is often difficult to distinguish mere obstruction from strangulation, especially when the former is associated with some inflammation of the sac. When in doubt, the case should be treated like one of strangulated hernia. *Treatment.*—A purgative enema, rest in the recumbent position, warmth or ice to the part, and restriction of diet should be prescribed. When there is no vomiting, a brisk purge is often successful, but before giving such the surgeon should thoroughly assure himself that strangulation does not exist. The application of the taxis is advised by some, and doubtless, in some instances, the intestine may be emptied of its contents by this means. It should be remembered, however, that its use is not unattended with risk.

5. INFLAMED HERNIA.—In this condition the sac and, to some

extent, its contents are inflamed. Inflammation is most common in small irreducible epiploceles, and is generally the result of injury, the pressure of a badly-fitting truss, or of violent exercise. If neglected the hernia is apt to pass into a condition of strangulation.

The *local symptoms* resemble those of a strangulated hernia, but the impulse on cough is not absent, though it may be less marked than in a hernia in its ordinary state, and there is not so much tension in the sac as when strangulation exists. The parts are hot, tender, and œdematous, and there may be feverish symptoms, vomiting, and constipation. The vomit consists, however, only of the contents of the stomach, and is not fæcal; the constipation is seldom complete; and flatus will usually pass.

Treatment.—An ice bag should be applied over the hernia, and the patient placed in the recumbent position, with the parts as much as possible relaxed. The diet should be restricted to small quantities of milk and beef-tea, and opium administered in small doses. When all signs of inflammation have subsided an enema may be given if the bowels do not act spontaneously. Should the inflammation run on to strangulation, herniotomy must be performed; whilst, should suppuration, a very rare event, occur, the pus must be let out by a free incision.

Fæcal fistula and artificial anus after operation for strangulated hernia.—Fæcal fistula is due to ulceration of the mucous membrane at the seat of stricture, and subsequent perforation of the bowel; artificial anus, to the gangrene of a considerable portion of the strangulated bowel. In both, adhesions form between the serous coat of the intestine and the parietal peritoneum, and in this way prevent the extravasation of fæces into the general peritoneal cavity; but in the fæcal fistula the perforation of the bowel being small, most of the fæcal contents are passed per anum; whereas, in artificial anus, the whole escape externally, and the intestine below shrinks and becomes more or less atrophied. In fæcal fistula only a fistulous aperture, discharging fæces, is present; in artificial anus the openings of the upper and lower portions of the intestine can generally be seen. The upper opening may be known by its larger size, redder colour, and by fæces issuing from it, whilst at times its mucous membrane may be prolapsed.

Treatment.—A fæcal fistula will, as a rule, close spontaneously, and beyond keeping the parts clean, nothing is generally required. In artificial anus the spur-like process or *éperon* formed by the projecting forwards of the posterior wall of the bowel by the coils of intestine which lie in the angle between the upper and lower portions of the intestine, may have first to be destroyed by Dupuytren's enterotome, and the lumen of the bowel being thus restored, the artificial anus may be closed by a plastic operation, or the walls of the bowel united by suture. The enterotome consists of two blades, one of which is passed into each portion of the bowel. By a screw arrangement the blades are then tightened and the intervening portions of the walls of the gut are slowly destroyed. The blades should not be passed far into the bowel for fear of including a knuckle of intestine which might happen to have descended into the angle of the spur between them. The surgeon, however, should not be in too great haste to employ the enterotome, as in the course of time, in consequence of the dragging of the mesentery, the spur-like process may become gradually retracted, and the two portions of intestine, instead of lying parallel, may be drawn to more or less of an angle with each other. In this way the lumen of the tube may become gradually restored, and the fæces again pass down the lower tube. A plastic operation will then only be required to close the external opening, if indeed this does not heal spontaneously, as in fæcal fistula. Thus, a ring of skin half an inch wide should be removed from around the opening, the adherent intestine separated from the parietes, the mucous membrane turned inwards, the raw intestinal walls united by non-penetrating sutures, and the refreshed surfaces of the parietes brought into contact by deep sutures.

Special Herniæ.

The three most common forms of hernia are:—the inguinal, the femoral, and the umbilical. Of the rarer forms may be mentioned the obturator, the ventral, the epigastric, the diaphragmatic, the lumbar, the ischiatic, the perineal, the vaginal, and the rectal.

INGUINAL HERNIA is one which escapes into or through the inguinal canal. Of this form there are three chief varieties, the oblique or external, the direct or internal, and the interstitial, in which there is a second sac extending between the abdominal parietes.

THE OBLIQUE OR EXTERNAL VARIETY is so called because it descends *obliquely* through the inguinal canal, and leaves the abdomen *external* to the deep epigastric artery. The hernia enters the canal by the internal abdominal ring, and may remain in the canal, when it is spoken of as *incomplete*, or, from its resemblance to a bubo, as a *bubonocele;* or it may pass through the canal and out of the external abdominal ring, when it is said to be *complete*, and is then termed a *scrotal* or *labial* rupture, according as it descends into the scrotum or labium. The *coverings* of an oblique inguinal hernia differ according as it is complete or incomplete, or occurs in the male or in the female. When *complete and in the male* they are from without inwards, 1, skin; 2, superficial and deep fascia; 3, intercolumnar fascia; 4, cremasteric fascia; 5, infundibuliform fascia; 6, subperitoneal fat; and 7, peritoneum, which constitutes the sac. In the *female* the cremasteric fascia is wanting, otherwise the coverings are the same. In the *incomplete* the only difference in the coverings is that in place of the intercolumnar fascia there is the aponeurosis of the external oblique, and in place of the cremasteric fascia the lowermost fibres of the internal oblique and transversalis; they are the same in the male and female. The *stricture*, when the hernia is strangulated, will be situated at the external abdominal ring, the internal abdominal ring, or anywhere in the inguinal canal between the two rings.

Varieties of oblique inguinal hernia.—These will perhaps be better understood by reference to the accompanying diagrams. The following are those most commonly described:—

1. The *common* or *acquired form* (*the inguino-scrotal of Birkett*). The sac here consists simply of a protrusion of peritoneum through the inguinal canal, and the hernia when complete may descend into the scrotum or labium. The testicle can always be felt either below or below and behind the hernia (Fig. 329).

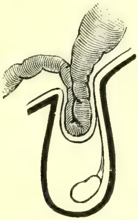

FIG. 329.—Ordinary acquired inguinal hernia. (Bryant's Surgery.)

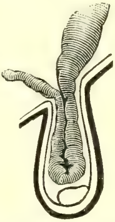

FIG. 330.—Congenital inguinal hernia. (Bryant's Surgery.)

2. The *congenital*.—In this form the hernia descends into the funicular process of the peritoneum, which has remained open, and comes into contact with the testicle, the funicular process and tunica vaginalis of course forming the sac. The testis is more or less surrounded by the hernia, instead of being felt distinctly behind and below it, as in the former variety (Figs. 330 and 331).

3. The *hernia into the funicular process* resembles the congenital, in that the hernia descends into the funicular process of the tunica vaginalis, but differs in that it does not reach the testicle, being cut off from it by a septum at the epididymis. Should an operation be required in this form, the testicle is not seen as in the congenital.

4. The *encysted congenital* (Fig. 332). In this form the funicular process of the tunica vaginalis is cut off from the peritoneal cavity by a septum at the internal ring. The septum yields to the pressure of the hernia, and becomes invaginated before it into the unobliterated funicular process, which is nearly always distended with fluid (*infantile hydrocele*) and consequently may obscure the evidence of a hernia. Should an operation be necessary, the

anterior layer of the funicular process, and the elongated septum forming the spurious sac, will have to be cut through. Here, as in the funicular variety, the hernia is not in contact with the testicle.

5. The *infantile hernia* is one in which the intestine, enclosed in its sac, descends behind the funicular process of the tunica vaginalis, which has remained unobliterated and distended with fluid (*infantile hydrocele*), but is cut off by a septum at the internal abdominal ring from the general peritoneal cavity. Should an operation become necessary, three layers of peritoneum have to be cut through, viz., the anterior layer of the unobliterated funicular process of the tunica vaginalis; the posterior layer of the same; and finally, the true sac. The last two, however, are generally intimately blended, so that there are apparently only two layers to cut through. These layers are separated by the hydrocele fluid which escapes when the anterior layer is divided, and may lead the surgeon into the mistake that the true sac has been opened.

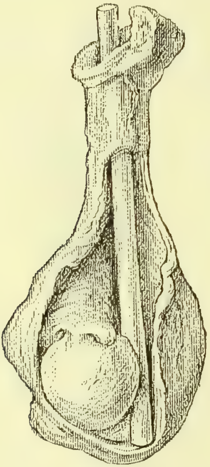

Fig. 331.—A congenital inguinal hernia. The roll of paper is that originally placed in the specimen by Percivall Pott. (St. Bartholomew's Hospital Museum.)

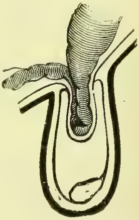

Fig. 332.—Encysted congenital hernia. (Bryant's Surgery.)

The direct or internal inguinal hernia is so called because it escapes *directly* through the external abdominal ring without traversing the internal ring and the whole length of the canal, and is situated *internal* to the deep epigastric artery. Before escaping at the external abdominal ring it either passes through or under the conjoined tendon of the internal oblique and transversalis, which is situated immediately behind the external abdominal ring; or it protrudes that structure in front of it. The *coverings* from without inwards are: 1, skin; 2, superficial and deep fascia; 3, intercolumnar fascia; 4, transversalis fascia; 5, subperitoneal fat; and

6, peritoneum forming the sac. When the conjoined tendon is protruded in front of the hernia, this of course constitutes an additional covering, and will then be found between the intercolumnar and transversalis fasciæ. It will thus be seen that the coverings of the direct hernia differ from those of the oblique, in the absence in the former of the cremasteric fascia, and in the substitution of the transversalis for the infundibuliform fascia. The spermatic cord with its coverings from the cremasteric and infundibuliform fascia lies to the *outer* side. From what has been said above, it will be seen that the epigastric artery is situated on the inner side of the neck of the sac in the oblique; on the outer side in the direct. The *stricture* when the hernia is strangulated will be situated at the external abdominal ring or at the aperture in the conjoined tendon through which the hernia has passed.

Two *varieties* of direct inguinal hernia are described according as the protrusion takes place internal or external to the obliterated hypogastric artery, but are not of sufficient importance to be described here.

Signs and diagnosis of inguinal hernia.—There is a swelling in the inguinal region having the general characters of hernia already given. When *incomplete* the swelling will be in the groin, and has to be chiefly distinguished from enlarged inguinal glands, a femoral hernia, encysted hydrocele of the cord, non-descended testicle, abscess in the inguinal canal, and, in rare instances, from fatty and other tumours of the cord. When it is *complete*, *i.e.*, has passed into the scrotum, the diagnosis has to be made from hydrocele of the tunica vaginalis, hæmatocele, solid tumours of the testicle, and varicocele. 1. In *enlarged glands* the canal is free, the glands are felt in front of it, and some cause is present to account for their enlargement. 2. In *femoral hernia* the swelling is external to the spine of the pubes, the neck of the hernia is below Poupart's ligament, the inguinal canal is free, but the hernia can be felt through its front wall, and to return it pressure must be made in a direction downwards, backwards, and then upwards. In inguinal hernia, on the contrary, the swelling is internal to, or covers the spine of the pubes; the neck is above Poupart's ligament; the inguinal canal is occupied by it, and to return it pressure must be made upwards and outwards. 3. In *encysted hydrocele of the cord* the swelling is translucent, tense, oval, and well-defined. There is no expansile impulse on cough; and it cannot be returned into the abdomen. 4. In *retained testicle* that organ is absent from the scrotum; there is no impulse on cough; testicular sensation can be obtained by pressure on the swelling; and it cannot be returned into the abdomen. If the testicle is inflamed or the cord is twisted (see *Torsion of the Spermatic Cord*), vomiting may be present, but it has not the gushing character of the vomiting of hernia, and constipation, if also present, is not complete. There may, however, be a strangulated hernia in addition to an inflamed testicle. The diagnosis in such a case is very difficult. If in doubt an exploratory incision should be made over the tumour. 5. In *hydrocele of the tunica vaginalis* the tumour is translucent, tense, and semi-fluctuating; there is absence of impulse on coughing, freedom of the cord, and a history of it having begun at the bottom of the scrotum. In infants, however, a hernia may be translucent, and in a hydrocele of the congenital variety the fluid can be pressed back into the abdomen, but it does not return with the gurgle or slip characteristic of a hernia. 6. In *varicocele* the dilated veins feel like a bag of worms in the scrotum, and the impulse on cough has a thrill-like character. A varicocele, like a hernia, is reduced on the patient lying down, but if the finger is placed firmly over the ring, the veins, on the patient rising, refill, notwithstanding the pressure of the finger, whereas a hernia would remain reduced. The *indirect* hernia cannot practically be distinguished from the *direct*, as the rings get dragged opposite one another. The indirect is more common in the young, the direct in the old.

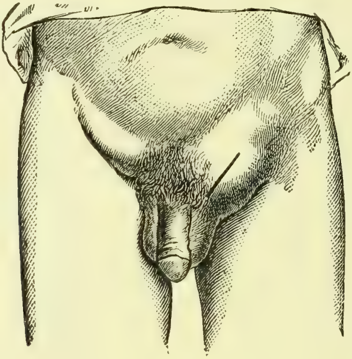

FIG. 333.—Oblique inguinal hernia, with line of incision.

Treatment.—What has already been said on this subject with regard to hernia generally is applicable here, and it need only be added that if an operation is necessary the incision (Figs. 333 and 334) should be made downwards and inwards, over the long axis of the hernia, beginning just above the external abdominal ring, or at the internal ring if it is decided to divide the stricture from without inwards (see p. 655); that the stricture, whether the hernia be direct or indirect, should be divided *directly upwards*, so as to avoid the epigastric artery; and that when combined with retained testicle a truss with a <-shaped pad should be worn if practicable above the testicle. If the truss causes the testicle to become frequently inflamed, the testicle had better be removed (See *retained testis*).

AN INTERSTITIAL HERNIA is one in which a second sac extends between the abdominal parietes, the two sacs opening into the peritoneal cavity by a common mouth. It is rare, but three chief varieties have been described; in (1) the second sac passes between the external and internal oblique muscles (the commonest form); in (2) it passes between the transversalis fascia and peritoneum (the rarest form); and in (3) it protrudes between the skin and external oblique muscle. The second sac in the more common variety forms a rounded or oval, somewhat flattened, swelling, extending from the external abdominal ring upwards and outwards along Poupart's ligament towards the anterior iliac spine. The original sac is commonly small and does not as a rule reach the scrotum or labium.

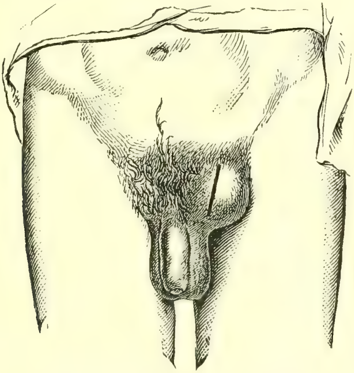

FIG. 334.—Direct inguinal hernia, with line of incision.

A FEMORAL HERNIA is one that escapes into the femoral sheath, and nearly always internal to the femoral vessels, though in very exceptional cases it has been found external to them. As a rule, it leaves the abdomen at the femoral ring, and after passing downwards through the femoral canal, emerges at the saphenous opening, and then turning upwards and outwards over the falciform process of the fascia lata, passes, should it further increase in size, over Poupart's ligament on to the aponeurosis of the external oblique muscle of the abdomen. The neck of the sac is situated at the *femoral ring* (Fig. 335), and is therefore bounded in front by Poupart's ligament, behind by the bone, internally by the sharp wiry edge of Gimbernat's ligament, and externally by the femoral vein, from which it is only separated by the innermost septum of the femoral sheath. The spermatic cord is close above it; the epigastric artery passes a little external to it; but there is no structure of importance, as a rule, on its inner, and upper and inner side. The obturator artery, however, may be given off from the epigastric or external iliac artery, and encircle this part of the ring in its course to the obturator foramen (Fig. 335). It is then in great danger of being wounded in dividing the stricture. Fortunately, however, although the artery often arises in this abnormal manner, it does not then, as a rule, take the above-mentioned dangerous course, but passes along the outer side of the ring where it is out of danger. The *coverings of a femoral hernia* are—(Fig. 336) 1, skin; 2, superficial fascia; 3, cribriform fascia; 4, anterior layer of the femoral sheath, called the *fascia propria;* 5, septum crurale; 6, subperitoneal fat; and 7, peritoneum forming the sac. The fascia propria is often very thin, or in places absorbed, so that little more than skin and one or two delicate layers of fascia cover the sac. But it may be greatly thickened, especially over the neck of the sac, where it may form distinct fibrous bands, which go by the name of the *deep crural arch.* Femoral hernia is never congenital except where there is a hernia of the testis or ovary (*crural ectopia of testis or ovary*); and seldom occurs before adult life. It is more common in women than in men. The *stricture*, when the hernia is strangulated, is at the saphenous opening, at Gimbernat's ligament, or more rarely at the deep crural arch.

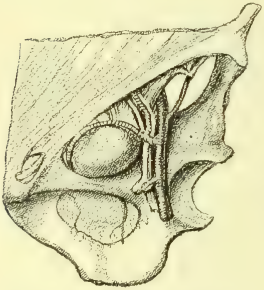

FIG. 335.—The obturator artery given off abnormally from the epigastric, and running round the upper and inner side of a femoral hernia. (St. Bartholomew's Hospital Museum.)

Signs.—A femoral hernia usually appears (Fig. 337) as a tense globular swelling at the upper and inner part of the thigh, just below Poupart's ligament internal to the femoral vessels, and external to the spine of the pubes. It is usually small, but may sometimes be as large as an orange, or even larger. It then extends upwards and outwards over Poupart's ligament towards the iliac spine, and appears as an elongated soft and yielding swelling with its long axis parallel to the ligament. Its neck, however, can always be traced below the ligament towards the femoral ring. The characteristic signs of hernia are, of course, present.

The *diagnosis* has chiefly to be made from enlarged glands, varix of the saphenous vein, inguinal hernia, and psoas abscess. 1. In *enlarged glands* there is no impulse on cough; they can be raised from the deeper tissues, and there will probably be some evident cause, as a sore on the heel, &c., to account for them. A small piece of irreducible omentum, however, may almost exactly resemble an enlarged gland in the femoral canal; and it may be impossible to make a diagnosis without exploring the ring, an operation which should always be undertaken if symptoms of strangulation of the intestine are present. At times there may be an enlarged gland over a hernia. 2. In *varix of the saphenous vein* the vein is generally also varicose lower down the limb, and the impulse on coughing has a peculiar thrill-like character, and extends also some distance down the vein. When the swelling is reduced by placing the patient on her back, and the ring is closed by the finger, the vein refills when she rises, whereas the hernia remains reduced as long as the finger is kept in position. 3. In *inguinal hernia* the neck of the sac is above Poupart's ligament, and inside or over the spine of the pubes; in femoral hernia the neck is below Poupart's ligament and outside the spine of the pubes. In

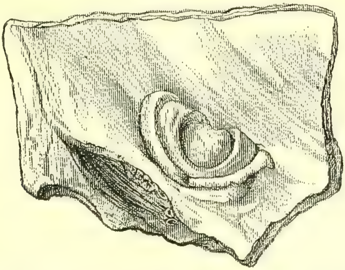

FIG. 336.—Femoral hernia. The coverings dissected off to show the sac. (St. Bartholomew's Hospital Museum.)

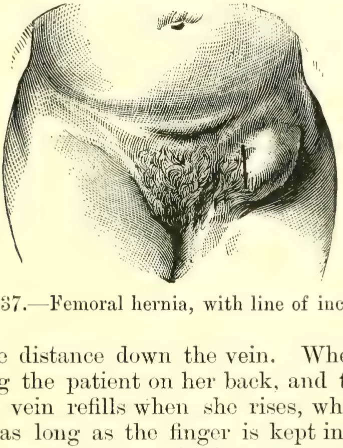

FIG. 337.—Femoral hernia, with line of incision.

inguinal, the hernia goes back in a direction upwards, outwards and backwards; in femoral, downwards, backwards and upwards. In inguinal, the hernia occupies the inguinal canal, and may descend into the scrotum or labium; in femoral, the inguinal canal is felt free on passing the finger into it. 4. In *psoas abscess* the swelling is generally at first external to the femoral vessels. There is usually fulness in the iliac fossa, and fluctuation can be detected above and below Poupart's ligament. Some cause for the abscess, such as caries of the spine, is generally evident.

Treatment.—All that need be mentioned in addition to what has already been said of the treatment of hernia in general is:—1. That the femoral truss (Fig. 317) should have the pad more vertically placed, and the button for the strap should be on the end of the spring and not on the back of the pad, as, if placed in the latter situation, it causes the pad to rise up and so allows the hernia to escape beneath it. 2. That in applying the taxis the leg should be flexed, slightly adducted, and rotated inwards, to relax the falciform process of the fascia lata. 3. That on account of the unyielding nature of the parts there is but little prospect of reducing the hernia under chloroform or by a hot bath. 4. That should the hernia become strangulated, ulceration is rapidly produced, owing to the pressure of the wiry edge of Gimbernat's ligament. Therefore, if the hernia is not returnable by moderate taxis, an operation should immediately be performed. 5. That the incision (Fig. 337) should be made in a vertical direction over the inner side of the neck of the hernia, the skin being nipped up and transfixed to avoid injuring the sac, as the coverings are often very thin. 6. That the stricture should be divided in an upward and inward direction through the junction of Gimbernat's with Hey's ligament. If made directly inwards, the resulting aperture is so large that it is difficult subsequently to keep up the hernia with a truss; while if made directly upwards, the spermatic cord and epigastric artery, and if outwards, the femoral vein, are endangered. 7. Several small notches are preferable to a single and larger incision, as there is less danger of wounding an abnormal artery should one be present. 8. Should such an abnormal artery be wounded it must be tied if possible, enlarging the incision if necessary; otherwise an attempt may be made to twist it or a pressure forceps may be left on.

UMBILICAL HERNIA (EXOMPHALOS, OR OMPHALOCELE) is one that escapes at the umbilicus. There are three distinct forms, the congenital, the infantile, and the acquired. 1. The *congenital* is due to an arrest of development, whereby the somatic ring is imperfectly closed, and a portion of intestine remains outside the abdomen enclosed by the tissues of the cord. This form is rare. The *infantile* is produced by a stretching of the umbilical cicatrix, and usually appears soon after birth as the result of crying, coughing, or straining to pass water, consequent upon a phimosis or narrow meatus. 3. The acquired form, according to Mr. Birkett, consists of a protrusion of the parietal peritoneum through the fibres of the linea alba, near the umbilicus, and seldom appears before middle adult life. It is especially common in stout females who have borne many children. The sac is usually very thin, frequently cribriform or altogether deficient in places, and is often lobulated, double, or composed of several pouches or sacculi, the result of adhesions between the walls and the contents. It commonly contains omentum, in which large masses of fat have been formed, and part of the transverse colon, and sometimes a knuckle of small intestine, which mostly lies concealed by the omentum at the neck of the sac. The coverings are:—1, the skin; 2, the superficial and deep fascia with a thin layer of fat between them; 3, the fascia transversalis; and 4, the peritoneum, which constitutes the sac. They frequently, however, become thinned, adherent to one another, or partially absorbed, so that the contents of the hernia are merely covered with skin and a thin layer of fascia (Fig. 338).

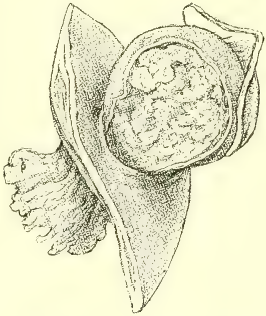
Fig. 338.—Umbilical hernia, showing the attenuated condition of its covering. (St. Bartholomew's Hospital Museum.)

Symptoms.—In infancy, the hernia, which is known by nurses as "starting of the navel," consists of a protrusion at the umbilicus, covered by thin skin, and readily returning when gentle pressure is applied, and when once seen can hardly be mistaken for any other affection. It generally undergoes a spontaneous cure. In adults it forms a globular, lobulated, or sometimes a pendulous or pyriform swelling, on the lower part of which the cicatrix of the navel is seen. It often attains a large size, nearly always extending, as it enlarges, downwards towards the pubes, and is frequently in part or completely irreducible. It is very liable to become obstructed and less often strangulated, and after it has existed some time is nearly always irreducible. It is often attended by flatulency, dyspepsia, and colic, and by alternate attacks of constipation and diarrhœa.

Treatment.—In infants the hernia generally undergoes a spontaneous cure, and nothing is required beyond drawing the margin of the hernial ring together, with a piece of strapping applied transversely over the hernia. Circumcision should be done if the prepuce is long and its orifice narrow. In adults, an umbilical truss or bandage is necessary, or when the hernia is irreducible, a hollow supporting truss. When the hernia is incarcerated, the patient must be placed at rest and an enema administered. When strangulated, an operation must be performed, but the prognosis is very grave. The incision should then be made vertically over the swelling in the middle line, and the sac opened with care, as the coverings are often very thin, and the stricture divided in an upward direction. If omentum presents first, as is usually the case, search must be made for intestine, and the latter returned; the omentum must then be unravelled, transfixed with a double ligature, tied, cut off, and the stump also returned. The sac should then be cut off with the redundant skin and the wound sewn up in the way described on p. 644. Radical cure is called for when a truss fails to keep up the hernia and obstruction or strangulation is frequently occurring, provided the patient is not inordinately stout and the hernia so excessive in size that there would probably not be room in the abdomen for the return of its contents.

An obturator hernia is one that escapes through the obturator canal, *i.e.*, the aperture left in the obturator membrane for the passage of the obturator nerve and vessels. The neck of the sac is bounded by the horizontal ramus of the pubes above, and by the sharp edge of the obturator membrane elsewhere; whilst the fundus either protrudes the obturator externus in front of it, or passes above that muscle or between its fibres and comes into contact with the pectineus, giving rise to a slight fulness in the upper part of the thigh just below Poupart's ligament, immediately behind and internal to the femoral vessels. The coverings, therefore, are—1, skin; 2, superficial fascia; 3, fascia lata; 4, pectineus; 5, fascia over the obturator externus; 6, obturator externus (sometimes); 7, pelvic fascia; 8, subperitoneal fat; and, 9, peritoneum, forming the sac, which is always an acquired one. The relation of the obturator artery and nerve to the sac is variable, but the nerve is generally to the outer side of the sac, and the artery to the outer side and behind. The hernia is always small, and generally consists of the lower portion of the ileum, often of only a portion of the calibre of the gut. Obturator hernia is rare; it is most often met with after the age of fifty, and then generally in women. It has not always been diagnosed during life, and is often accompanied by other herniæ.

Symptoms.—The chief of these, in addition to those of strangulation, which has generally been present, are a slight fulness below and internal to the femoral vessels, perhaps not perceptible unless the two sides are compared; pain down the inner side of the thigh from pressure on the obturator nerve; pain on pressing over the obturator foramen, and perhaps some increased resistance or swelling in this region; pain on rotating the thigh outwards from the obturator muscles, which are then put on the stretch, pressing on the hernia; and pain and swelling in the region of the obturator membrane on examination by the rectum or vagina. From *femoral hernia* it may be known by the neck being below instead of above the ramus of the pubes; and by the femoral ring being free.

Treatment.—This hernia has occasionally been reduced by taxis, aided in one instance by the hand in the vagina. But this method is dangerous inasmuch as the gut may be injured or may be in a state unfit to return into the abdomen. It is better therefore to make an incision similar to that for femoral hernia, but slightly longer, and having divided the various coverings and opened the sac, to incise the stricture in a direction downwards and inwards, avoiding if possible the obturator artery and nerve. Where the diagnosis is doubtful the ring should be explored either in the way described above or through an incision in the middle line of the abdomen, the hernia, if one is found, being in the latter case drawn out from the ring from within the abdomen, after the stricture has been cautiously divided.

DIAPHRAGMATIC, OR PHRENIC HERNIA, is one that protrudes through the diaphragm into the thoracic cavity. It is very rare in this country, but is said to be not uncommon in Italy from stabs aimed at the heart. The aperture may be due to a congenital defect, to the enlargement of one of the natural openings, or to a wound or laceration of the diaphragm. The hernia usually occurs on the left side, the liver tending to prevent any protrusion on the right. There is no peritoneal sac, the viscus, which is usually the stomach or transverse colon, escaping into the pleural cavity along with some omentum. In the Museum of St. Bartholomew's there is a unique specimen of a hernia of the omentum into the pericardium, the result of a wound.

Symptoms.—In some cases there have been no symptoms; in other cases unnatural fulness and abnormal resonance of the left side of the chest, with gurgling on auscultation, excessive thirst, and signs of internal strangulation have been observed. When the result of a wound, pleurisy or peritonitis, or both, have generally soon supervened and carried off the patient.

Treatment.—The hernia should be explored by incision, reduced, and the hole in the diaphragm sewn up.

The RARER forms of hernia, viz., the *ischiatic*, which leaves the pelvis through the greater ischiatic notch either above or below the pyriformis; the *lumbar*, which escapes between the quadratus lumborum and external oblique; the *perineal*, which presents between he vagina and the rectum; the *pudendal*, which escapes between he vagina and the ascending ramus of the ischium; the *rectal* and *aginal*, which protrude respectively into these cavities; and the *entral*, which escapes through the linea alba, are, on account of pace, only mentioned to be dismissed.

DISEASES OF THE RECTUM.

Congenital malformations.—Imperforate anus is the only malformation that needs consideration here. *Cause.*—The intestinal canal in early fœtal life ends at some little distance from the surface of the skin in a blind pouch or cloaca, which is common to it and the genito-urinary organs. In the course of development the cutaneous tissues (epiblast) become invaginated towards the cloaca at the spot which is to be the future anus. The intervening tissues are then gradually absorbed, and a communication is thus established between the cloaca and the surface of the body, the intestinal portion of the cloaca at the same time becoming differentiated from the genito-urinary. An arrest in the above process of development is the cause of imperforate anus. Thus:—1. Should no invagination of the skin occur, the anus will be entirely absent. In such a case the intestine may terminate in a blind pouch at a variable distance from the surface, a thin membrane or a considerable thickness of tissue intervening between the skin-surface and the interior of the gut. At times the intestine may stop short of the pelvis, the rectum being then of course wholly absent. 2. Should invagination occur, but the intervening tissues not be absorbed, an anus, to all external appearances natural, will be present but will be found to terminate in a *cul-de-sac* a short distance from the surface. Here again either a thin membrane, or a considerable thickness of tissue, may intervene between the top of the *cul-de-sac* and the interior of the gut. 3. Should the process by which the intestinal canal is normally cut off from the genito-urinary portion of the cloaca also fail, the intestine, instead of ending in a blind pouch, may communicate with the bladder, prostatic urethra, or vagina. In rare cases the intestine may open in some other abnormal situation, as the perineum or groin.

Treatment.—Where only a thin membrane intervenes its division is all that is necessary; but where there is no appearance of an anus, or evidently a considerable thickness of tissues between the gut and the surface, a vertical incision should be made in the middle line at the spot where the anus should be normally situated. If the distended bowel is now seen or felt to bulge in the wound it should be exposed with a few touches of the knife, and then cautiously opened by an incision made in the same direction as the wound. Should it not be thus discovered, the dissection must be carried on cautiously in an upward and backward direction for an inch to an inch and a half, of course keeping to the middle line and well towards the sacrum lest the peritoneum be wounded. If the bowel is detected it should be opened; no attempt, however, should be made to bring it down, but a bougie passed daily to prevent the wound re-contracting. If not found in this way the colon may be opened in the left loin (*lumbar colotomy*) or in the left groin (*inguinal colotomy*). Opinions differ as to which of these operations is preferable. There are advantages and disadvantages attending each which cannot be here discussed. On the whole the operation in the groin in my opinion is the best.

Mayo Robson advises us to continue the dissection in the perineum, open the peritoneum, seek the end of the gut, pull it down, and fix it to the skin. The only objection I can see to this method is the extreme smallness of the parts in the new-born infant.

PROCTITIS or inflammation of the rectum is rare. It may be due to injury, gonorrhœa, or dysentery, and run an acute or chronic course. It is attended by pain, tenesmus, bloody stools, and œdema, and should be *treated* by rest, saline purgatives or castor oil to empty the rectum, slop diet and hot sitz-baths, and starch and opium enemata to relieve pain. When it has become chronic, astringent injections may be tried.

PRURITUS ANI, or itching about the anus, though often dependent upon constipation, ascarides, pediculi, eczema marginatum, condylomata, piles, or other diseases of the rectum, sometimes occurs without any very evident cause, and has then been attributed to disordered digestion and gouty habit. *Symptoms.*—The itching is often intolerable, and is usually worse soon after the patient gets warm in bed. There may be some slight cracks, a little eczema from the scratching, or a moist and reddened condition of the skin, but occasionally there is nothing to be seen. *Treatment.*—The cause if possible should be removed. Where none is very evident the general health must be attended to, the parts kept scrupulously clean, and an ointment or lotion of perchloride of mercury, boracic acid, nitrate of silver, cocaine, &c., applied. I have found lactate of lead, made by pouring lead lotion into milk, to have a very beneficial effect.

FISSURE OF THE RECTUM is a small painful crack or ulcer usually situated just within the anus, and seldom involving more than the skin or mucous membrane. *Causes.*—Almost always constipation; sometimes neglect of local cleanliness, or other source of irritation The passage of an unusually hard motion is often the immediate exciting cause. When the ulcer is once thoroughly established, healing is prevented by the action of the sphincter and the irritation of its surface during the passage of a motion. Ball attributes it to the tearing of one of the small anal valves situated at the junction of the rectum and anus, and regards the small pile at the distal end of the fissure as an œdematous condition of the torn-down valve. *Symptoms.*—The chief of these is pain, the result of spasm of the sphincter. It is often very severe, and occurs during and after defæcation. It may last for a few minutes or longer, even to several hours, and then ceases till the next motion. The pain may not only be felt in the anus, but may be reflected down the thighs or to other parts, as the uterus, vagina, or testicle. The motions are often slightly streaked with blood, sometimes with pus. On examination the sphincters are found spasmodically contracted. On gently everting the margins of the anus the end of the ulcer will be discovered usually at the posterior part, a small external pile or an œdematous fold of skin which is generally present then serving as a guide to it. The passage of the finger is attended with great pain. *Treatment.*—In slight cases the use of laxatives and the application of astringent lotions or sedative ointments before and after defæcation may be sufficient. If these fail the sphincter may be forcibly dilated, or the ulcer divided, together with half or more of the external sphincter, by drawing a straight bistoury longitudinally through the base of the ulcer. The bowels should then be kept confined for four or five days, and the motions afterwards kept soft for a fortnight or longer. Or the sphincter may be divided subcutaneously by passing a tenotomy knife beneath it, through the mucous membrane, and cutting outwards towards the skin. Ball treats these cases by cutting off the small pile at the end of the fissure. This little operation, and that of subcutaneous division of the sphincter, may be done without pain by painting the mucous membrane with cocaine or spraying it with chloride of ethyl, and does not necessitate the patient's lying up for more than two or three days.

Prolapsus recti is the protrusion of the mucous membrane of the lower part of the rectum, and more rarely of the muscular coat as well, through the anus. It is most common in children, but may occur at any age. The *causes* are either a relaxed state of the sphincter induced by general weakness, residence in hot climates, &c., or excessive straining due to stricture of the urethra, phimosis, stone, ascarides, constipation, piles, or polypus. *Signs and diagnosis.*—It commonly appears as an irregular ring of mucous membrane, or when much is protruded, as a cylindrical elongated swelling. When recent, it has the colour of healthy mucous membrane, but if not soon reduced it may become livid and congested, in consequence of constriction of the blood-vessels by the sphincter. The strangulation may proceed to such an extent that the prolapsed portion may undergo mortification and slough away. In old-standing cases it becomes indurated and leathery from exposure. It may be diagnosed from polypus by the presence of a central aperture, and from intussusception by the mucous membrane being continuous with that of the sphincter. In intussusception a sulcus exists between the protruded part of the bowel and the sphincter.

Treatment.—Should the bowel be protruded or strangulated, an attempt should be made to reduce it. If it has only been prolapsed a short time, this is easily accomplished by gentle pressure, the parts having been well smeared with vaseline and the buttocks raised. When of longer standing, firm pressure must be exercised on it for ten minutes or so, or the finger may be introduced into the orifice and the bowel pressed back. If reduction fails and the part is much inflamed, an ice-bag may be applied, and another attempt subsequently made, when, if still unsuccessful, nothing remains but to allow the protruded part to slough off or to excise it. If the muscular coat protrudes, no operation should be done lest the peritoneum be wounded. Having reduced the bowel, the cause of the prolapse should, if possible, be removed, and to prevent a recurrence the nates may be strapped together, or a pad and T-bandage worn, and the motions passed at bed-time instead of in the morning, the patient lying on his side or back during defæcation. Astringent lotions or ointments of sulphate of iron, galls or tannin should be applied, or the mucous membrane painted with nitrate of silver, whilst any pendulous folds of skin may be snipped off, so as to cause some amount of contraction of the anus. In the meanwhile, the motions should be rendered soft with gentle laxatives. Should these means, after being well persevered in, fail, a more serious operation may become necessary. Thus, portions of the mucous membrane may be removed by ligature; or the galvano-cautery may be applied in two or three situations, so as to produce lines of burns in the long axis of the bowel, and thus cause the mucous membrane to adhere to the muscular coat by inflammation.

HÆMORRHOIDS OR PILES are swellings inside or around the margin of the anus, the result of a dilated or varicose state of the blood-vessels.

Causes.—The peculiar anatomical arrangement of the hæmorrhoidal veins; the absence of valves in them and in the veins through which they communicate with the portal vein, whereby they have to sustain the whole weight of the column of portal blood; and their situation between the muscular and mucous coats of the rectum, so that they receive but little support during defæcation, render them exceedingly liable to become dilated or varicose. Anything, therefore, that tends to congest the portal system, and hence obstruct the return of venous blood from the hæmorrhoidal veins, such as high living, habitual constipation, cirrhosis of the liver, heart-disease, &c., may be looked upon as a predisposing cause; whilst anything determining local congestion of the part, such as straining at stool or to pass water in cases of enlarged prostate or stricture of the urethra; the pressure of the gravid uterus, distended colon, or ovarian or other pelvic tumour; stricture of the rectum; and the abuse of aloetic purgatives, may be regarded as an exciting cause.

Pathology.—Hæmorrhoids consist at first of little more than dilated veins, but after they have existed some time the blood in their interior may clot, the vein-walls hypertrophy, and the connective tissue of the dilated vein become infiltrated and thickened. If a pile is now cut into, it presents a spongy vascular structure, and there is often a small artery in its centre. Piles may be situated external to the sphincter, and are then covered with skin (*external or blind piles*); or within the sphincter, when they are covered with mucous membrane (*internal or bleeding piles*). In many instances, however, they may be covered in part with skin, and in part with mucous membrane (*mixed piles*). An œdematous and swollen condition of the muco-cutaneous folds and hypertrophied flaps of skin about the margin of the anus, although not produced by dilatation of the veins, is also generally spoken of as piles. *External piles* occur as soft, globular, pinkish-blue swellings, or as moderately firm fleshy tumours, or as little more than loose hypertrophied folds of skin. *Internal piles* also present various forms. They may consist of small hæmorrhoidal veins, dilated and varicose, giving the mucous membrane a dark purplish colour, and rendering it liable to become prolapsed during defæcation; or they may form either slightly raised, flattish and oblong elevations, or distinctly globular pedunculated swellings (Fig. 339). They may appear very vascular from the congestion of the mucous membrane covering them, and then constitute the bleeding pile; or they may be firm and fleshy and of a reddish-brown colour from the thickening of the mucous membrane, and then do not readily bleed. The hæmorrhage is usually arterial, and comes from the small arteries in the mucous membrane. Piles, whether external or internal, are at times liable to become inflamed and slough.

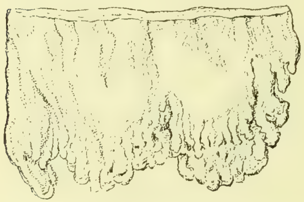
FIG. 339.—Internal piles. (St. Bartholomew's Hospital Museum.)

Symptoms.—*External piles*, beyond causing some amount of itching and unpleasant sensations about the anus, may give rise to no symptoms unless irritated or inflamed. They are then often a source of much distress. The pile becomes swollen and painful, the pain being reflected to the surrounding parts and increased on sitting, standing, and walking. The acute symptoms usually subside in a few days, but often leave the parts thickened and irritable, and are liable to recur from time to time. *Internal piles* are productive of more trouble, the chief symptoms to which they give rise being hæmorrhage, and irritation and pain consequent on their protrusion and constriction by the sphincter or as the result of their becoming inflamed; whilst the hæmorrhage, when severe, may be productive of anæmia and all its attendant constitutional symptoms. The amount of hæmorrhage may vary from a few drops—a mere streaking of the motions with blood—to several ounces.

When first noticed, the protrusion of the piles occurs only during defæcation; and although they may at first go back spontaneously, they often require replacement by the finger, as otherwise they are apt to become strangulated by the sphincter and irritated or inflamed from the chafing of the clothes. Later the sphincter becomes dilated, and they may protrude at times other than during defæcation, and in long-standing cases the mucous membrane becomes permanently prolapsed, and the pile remains constantly protruded. External piles then generally form in addition to the internal, whilst the mucus exuded from the parts is a constant source of annoyance. The constitutional symptoms to which the loss of blood and the pain and irritation may give rise are pallor, palpitation, breathlessness, fainting and headache. From the reflex character of the pain the patient may refer the symptoms to other organs, as the testicle, bladder, kidneys, or uterus.

Diagnosis.—External piles may be readily diagnosed from condylomata, polypi, and carcinoma by the characters already given. *Internal piles* may be suspected from the above-mentioned symtoms, and if not protruded they may generally be brought into view by asking the patient to bear down as if to defæcate, whilst the surgeon makes gentle traction on the margin of the anus. If this does not succeed and the bowel is loaded, an enema should first be given. Examination with the finger, unless the surgeon has had some experience, fails to detect the pile, as when neither irritated, inflamed, nor protruded it is soft and flaccid, like the rest of the mucous membrane.

The *treatment* of piles may be divided into the palliative and the radical.

The *palliative* treatment consists in employing such means as are calculated to relieve the congestion of the hæmorrhoidal veins. Thus constipation must be combated by the use of such laxatives as the confection of senna, compound liquorice powder, the liquid extract or cordial of cascara sagrada, or Pullna or Friedrichshall waters; whilst strong purgatives, especially aloes, high living, and alcoholic stimulants should be avoided and the secretions of the liver promoted by exercise. Where there is hæmorrhage, the tincture of hamamelis or of steel will be found very useful. Locally, the parts should be kept scrupulously clean, and astringed by such applications as the liquid extract of hamamelis, the compound ointment of galls, or lotions of sulphate of iron, acetate of lead, or tannic acid, passed through the sphincter; or by injections of ice-cold water, to which tincture of hamamelis may be added. When the piles are inflamed, the patient should rest in bed with the buttocks raised, an ice-bag or hot poultice should be applied, and a morphia suppository introduced into the rectum. Where coagulation has taken place, free incision into the pile and turning out the clots will give relief.

The *radical* treatment consists in removing the piles but should only be resorted to when palliative measures after a fair trial have failed, or when the piles are more or less constantly down. It need hardly be said that no operation should be performed when they are merely symptomatic of some more serious disease, as stricture or cancer of the rectum, enlargement of the prostate, or disease of the uterus, bladder, or liver, or are the result of pregnancy. The method of removing the piles differs according as they are external or internal.

External piles may be simply snipped off with the scissors, care being taken, however, not to remove too much of the integument lest troublesome contraction of the anal orifice should ensue.

Internal piles may be treated by ligature, the clamp and cautery, crushing, injections with carbolic acid, excision, or the application of nitric acid. Whatever method is employed a purgative should be given the day before, and the rectum cleared on the morning of the operation by an enema; and after the patient is under the influence of the anæsthetic, the anus should be forcibly dilated to bring the parts well into view, and to paralyse the sphincter.

If the *ligature* is employed, the most prominent pile should be seized with the pile-forceps or pile-hook, and the mucous membrane incised with the pile-scissors at its junction with the skin, so as to detach the pile and mucous membrane from the anal margin. A carbolized silk ligature should then be placed in the groove thus formed and tied tightly around the undetached base of the pile, taking care to include as much of the mucous membrane above the pile as possible. The greater part of the pile having being excised, the ends of the ligature are cut off and the stump of the pile returned after the others have been treated in a similar way. The parts should be thoroughly dusted with iodoform, a morphia suppository passed into the anus, and a large pad of iodoform wool applied and secured *in situ* by a T-bandage. Some surgeons insert a rubber tube to allow flatus to escape, but I have found it cause considerable irritation and annoyance. The bowels should be kept confined for four or five days by small doses of opium combined with tincture of catechu, and then opened by castor oil or an enema of olive oil. Should retention of urine occur, as is very common after operations on the rectum, it should be relieved by passing a soft catheter. The ligatures generally come away about the ninth to the eleventh day.

Clamp and cautery.—A pile having been seized with the forceps, the clamp is applied to its base, the pile shaved off, and the raw surface cauterized.

If *crushing* is employed, the pile is drawn into the crusher, which is then screwed tightly home, the pile cut off, and the crusher removed after a minute or two.

Excision has of late been extensively employed by some surgeons. It consists in dissecting away the piles, tying any arteries that bleed, and bringing down the mucous membrane and securing it by suture to the anal margin.

Injections of carbolic acid.—The strength usually employed is half a drachm of the acid to a drachm each of glycerine and water, four or five minims being thrown into the centre of the pile by a hypodermic syringe. The process has to be repeated several times and takes some weeks to effect a cure.

Nitric acid is a useful and efficient application for the sessile vascular pile, and should be applied with a glass rod through a speculum, and any excess of acid removed by a weak alkaline lotion.

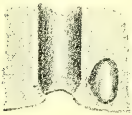
FIG. 340. — Ischio-rectal abscess.

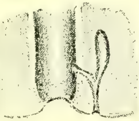
FIG. 341. — Complete fistula.

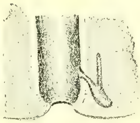
FIG. 342. — Blind internal fistula.

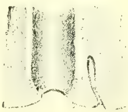
FIG. 343. — Blind external fistula.

An ISCHIO-RECTAL ABSCESS (Fig. 340), is one that forms in the loose cellular tissue in the ischio-rectal fossa, and should be distinguished, on the one hand, from the small abscesses which may occur round the margin of the anus in the cutaneous folds (*perianal*), and, on the other hand, from the abscesses which may form between the mucous and muscular coats of the rectum or round the gut in the pelvic cellular tissue. The *cause* of ischio-rectal abscess is inflammation around the rectum (*periproctitis*). The inflammation may be due to perforation of the mucous membrane by a fish-bone or other foreign body, followed by ulceration and the escape of fæces into the ischio-rectal fossa; or it may be due to injury from without, as a kick or blow. In tuberculous subjects abscess is common from very slight causes, and is probably then the result of the breaking down of a local deposit of tubercle. The *symptoms* vary according as the abscess is acute or chronic. The acute begins with pain, which soon becomes throbbing, and is followed by swelling and redness on one side of the anus, and later by fluctuation.

In the chronic the symptoms may be so slight as to escape notice till the abscess bursts into the bowel and the pus escapes by the anus. *Treatment.*—An early incision should be made in order to prevent, if possible, the abscess breaking into the bowel and a fistula resulting. The incision should be free and of a T-shape, to secure a free vent for the discharge and promote the healing of the abscess from the bottom, lest the abscess-cavity, as is very frequently the case, from the constant action of the sphincter, degenerate into a fistula (Figs. 341, 342, 343).

FISTULA IN ANO is a fistulous track by the side of the rectum. Three forms are described:—1. The *complete* (Fig. 341), in which the fistula opens internally into the rectum, and externally on to the skin; 2. The *blind external* (Fig. 343), in which it only opens on to the skin; and 3. The *blind internal* (Fig. 342), in which it only opens into the bowel.

The *complete* (Fig. 341) is by far the most common form. It generally extends obliquely upwards on one side of the anus and opens into the bowel between the external and internal sphincters, or it may take a curved course around the bowel and then open into it (*the horseshoe fistula*). Frequently it extends up beyond the internal opening by the side of the rectum in the form of a *cul-de-sac*; or it may, though very rarely, open into the bowel several inches above the anus. In rare instances there may be two internal openings. Secondary fistulæ branching off from the main fistula are often found burrowing beneath the skin of the perineum and buttock and sometimes opening at a considerable distance from the anus. The external opening, however, is usually about half an inch from the anus; but it may be a greater distance from it; or close to it, and then, perhaps, hidden by the loose folds of skin. It may be little more than a minute hole exuding a slight moisture; or it may be encircled by a ring of granulations, and the skin in its neighbourhood may be red and brawny. The fistulous track itself will generally be found lined with a smooth shining membrane, and its walls indurated when it has existed some time.

Causes.—A fistula is generally the result either of the bursting of an ischio-rectal abscess into the bowel, or on to the skin, or in both directions; or of ulceration or perforation of the mucous membrane and the extension of the ulcerative track downwards towards the skin, which it may or may not penetrate. It is often seen in phthisical subjects, and occurs as a complication of cancerous and other strictures of the rectum. The two chief reasons why the fistula does not close are the constant movements of the sphincter and the escape of fæcal matter into it.

Symptoms.—Uneasiness, pain or tenderness of the parts, especially on defæcation and movement; more or less constant discharge of pus or purulent fluid from the external opening; escape of fæces where the fistula is complete, or a discharge of pus from the bowel if the fistula is of the blind internal variety; mental worry, anxiety and depression; at times exacerbation of the inflammation with pain and increased discharge; and probably the history of a previous abscess having formed in the ischio-rectal fossa.

Diagnosis.—In the *complete variety* (Fig. 341) the diagnosis is readily made by passing a probe up the fistula into the bowel, and by feeling the internal opening (which has sometimes the form of a small depression in the centre of a slight papilla-like eminence) with the finger in the rectum. In the *blind internal* (Fig. 342) a soft spot in the centre of an indurated portion of the tissues by the side of the anus will be felt, and probably an indurated track will be detected leading from this towards the bowel. The internal opening, which has the characters given above, will be discovered just within the anus on passing the finger in the rectum. Into this opening a bent probe may be passed, and its end made to project under the soft spot on the skin-surface. In the *blind external* (Fig. 343) the probe cannot be made to enter the bowel on being passed up the fistula, and no internal opening can be felt in the rectum by the finger. In all cases the rectum should be carefully examined to exclude stricture or cancerous disease. From urinary fistulæ tracking down towards the anus a fistula in ano is readily distinguished by the characters given above, and by the absence of urethral and bladder trouble, and by no urine escaping through the fistula.

Treatment.—Although in exceptional instances fistulæ have closed spontaneously, an operation, as a rule, is required. Before operating for fistula the chest ought always to be examined, since, should tubercle in the lungs be discovered, no operation should be done unless the tubercle is in quite an early stage. The urine should also be tested for albumen, and the absence of stricture or cancer of the rectum determined. *Operation.*—A director should be passed through the fistula into the bowel, and its point hooked down and brought out at the anus by the index finger, which has been passed up the rectum. The bridge of tissue, which sometimes includes the external sphincter, is then divided by running a curved bistoury along the director. The upward prolongation of the fistula beyond the internal opening (Fig. 341) should next be laid completely open into the cavity of the bowel. A careful search should now be made with a probe for all secondary fistulæ or lateral sinuses, and these laid freely opened. The lining membrane of the fistula should next be destroyed by scoring it with a bistoury, or scraping it with a Volkmann's spoon, as otherwise the fistula is apt to re-form. The wound should finally be filled with iodoform wool, and a pad and T-bandage applied. When there have been secondary fistulæ extending widely into the surrounding tissue, I have succeeded in greatly lessening the time of healing by cutting completely away the lining membrane of the outlying portions and bringing the raw surfaces together by suture.

After the operation the bowels should be kept confined for about four or five days with small doses of opium, and then relieved by castor oil or an enema. The wound should be dressed daily with iodoform wool lightly pressed into it to ensure its healing from the bottom. When the internal opening is very high up a stout ligature may be passed and made to cut its way out, the fistula healing behind it. But as this takes a long time, it is better to reduce the fistula in this way to reasonable limits and then divide it. The *blind external* and the *blind internal* should, as a rule, be converted into complete fistulæ by forcing, in the former case a director up the fistula into the bowel, and in the latter by cutting through the skin on the point of a bent probe hooked into the internal opening, and made to project under the skin. Both are then treated as a complete fistula. In some cases of blind external fistulæ a free T-shaped incision will suffice without cutting through the sphincter or entering the rectum.

POLYPI generally occur as pedunculated growths springing from the submucous tissue, usually of the lower part of the rectum. They vary in size from a pea to a cherry, and in colour from white or pale pink to a deep red. The two chief forms are (1) the *soft or vascular*, which show microscopically an adenomatous structure with at times some amount of myxomatous degeneration, and are most common in children; and (2) the *hard or fibrous*, which are more rare and generally occur in adults.

Symptoms.—Polypi are the commonest cause of bleeding from the rectum in children, the blood escaping not only during but also after defæcation. When low down they cause straining, perhaps a mucous discharge, and pain after defæcation, from being caught in the sphincter. When large they may produce prolapse or intussusception. Small polypi beyond the reach of the sphincter may cause no symptoms. They are usually detected by sweeping the finger well round the rectum, the examination being best made after the bowels have been emptied and the polypus brought down by an enema.

The *treatment* consists in ligature of the pedicle, followed by excision of the growth. They do not recur.

PAPILLOMATOUS OR VILLOUS TUMOURS of the rectum are rare, and are most frequently met with in patients over forty years of age. They have a papillomatous structure, spring from the mucous membrane, and are generally multiple, often involving large tracts of the bowel (Fig. 344). Frequent hæmorrhages and the passage of a glairy mucous discharge are the chief signs. *Treatment.*—The larger tumours should be removed with as many of the smaller as can be got away. They are apt to recur and then to become malignant.

STRICTURE OF THE RECTUM may be divided into the simple and the malignant.

1. THE SIMPLE OR FIBROUS stricture may be caused by the fibroid contraction of inflammatory products in the mucous and submucous coats, or of cicatrices following simple, syphilitic, or dysenteric ulceration; by injury, or operation on the bowel; or it may be the result of pelvic inflammations (*peri- or para-metritis*).

Pathology.—The stricture is generally situated from one to two inches from the anus, but may occur at any part. It may involve only a narrow ring-like portion, when it is called annular; or it may include an inch or more of the gut, when it is sometimes spoken of as tubular. The strictured portion of the bowel consists in great part of fibrous tissue. The *syphilitic* variety, which is much more common in women than in men, is often combined with condylomata or ulceration about the anus, and the mucous membrane between the anus and the stricture is frequently ulcerated. The simple annular form met with in women is believed by some surgeons to be due to gonorrhœa. The bowel above is generally distended with fæces, the muscular coat hypertrophied, and the mucous membrane ulcerated; whilst, in the neighbourhood of the stricture, the coats are often so thin that the least force causes them to give way. Fistulæ often form below the stricture, and hæmorrhoids are a frequent concomitant.

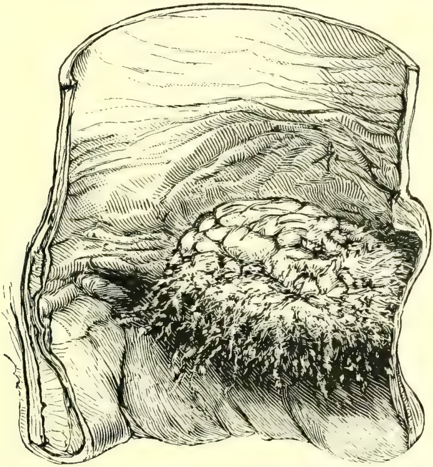

FIG. 344.—Papilloma of the rectum. (St. Bartholomew's Hospital Museum, No. 2,063 *a.*)

Symptoms and diagnosis.—Pain and difficulty in passing a motion, constipation, and later, constipation alternating with diarrhœa. The motions, when the stricture is near the anus, become small, ribbon-like, and streaked with discharge. There is a frequent desire to defæcate, but little passes except wind and discharge, and the bowel feels as if it had not been emptied. In tight strictures or in strictures with ulceration, fistulæ may sometimes form about the anus, and the patient gets worn out, and, after many years perhaps of suffering, may die of an attack of peritonitis or obstruction. The stricture is readily detected on passing the finger, but is often so tight that only the tip can be got into it. When this is the case on no account should the finger be passed through it, as the slight force of passing the finger may rupture the attenuated walls and peritonitis and death may follow.

Treatment.—As a rule, gradual dilatation by means of bougies, of which the soft flexible ones of Mr. Goodsall are perhaps the best, should be first attempted, and will generally be successful; but the stricture must be kept dilated by the subsequent occasional passage of a bougie. In exceptional cases, where the stricture is very resistant, a bougie may be tied in. Where the parts are much riddled by fistulæ a division of the stricture may be necessary. This may be done by what is called internal or external *linear proctotomy*. In the former operation the knife, guided by the finger, is introduced through the stricture, which is then divided in a posterior direction; in the latter, the stricture, together with the external sphincter and other intervening soft parts, are completely divided down to the coccyx.

2. MALIGNANT OR CANCEROUS STRICTURE.—*Pathology.*—Cancer in all its forms may occur in the rectum, but the most common is a variety of carcinoma known as the columnar or adenoid (Fig. 345). It occurs either as a fungating, more or less distinct tumour projecting into the lumen of the bowel, or as a laminar, nodular, or ring-like infiltration of its coats. In either case, it is at first covered by apparently unaltered mucous membrane, which, however, is sooner or later destroyed by ulceration, leaving an ulcer with an uneven, proliferating, or excavated surface, everted edges and an indurated base. As the disease extends it involves the muscular coat, and subsequently the surrounding structures and organs, gluing them, as it were, to the rectum, and finally converting the whole into a cancerous mass. The lymphatic glands in the pelvis, and later the inguinal glands and others more removed, become affected, and the carcinoma may finally be disseminated, secondary growths being more especially met with in the liver. The *symptoms* are often very insidious. At first there may be merely some uneasiness, hardly amounting to pain, about the anus; then more or less pain on defæcation is noticed; the fæces may be streaked with

mucus or with blood; and a slimy discharge may be present. Later the motions become small, flattened, or pipe-like when the stricture is near the anus, or scybalous when some distance above. The patient strains at stool, and feels as if his bowel had not been emptied; then there is constipation alternating with diarrhœa, and an offensive sanious discharge. Emaciation and cachexia now come on, with more local pain, and the patient dies of exhaustion, peritonitis, or during an attack of acute obstruction.

The *diagnosis* can only be arrived at by a local examination. The anus generally appears healthy, though probably patulous, and a healthy strip of mucous membrane generally exists between the anus and the growth. When the growth can be felt, its indurated base, and when ulceration has occurred, the everted edges of the ulcer, and the sanious and foul discharge, render the diagnosis generally easy. When beyond the reach of the finger it may at times be brought down by asking the patient to strain. The fungating form may be mistaken for a villous growth; the annular, for a simple fibrous stricture. A *villous growth* may be distinguished by its velvety and supple feel, by its not ulcerating and breaking

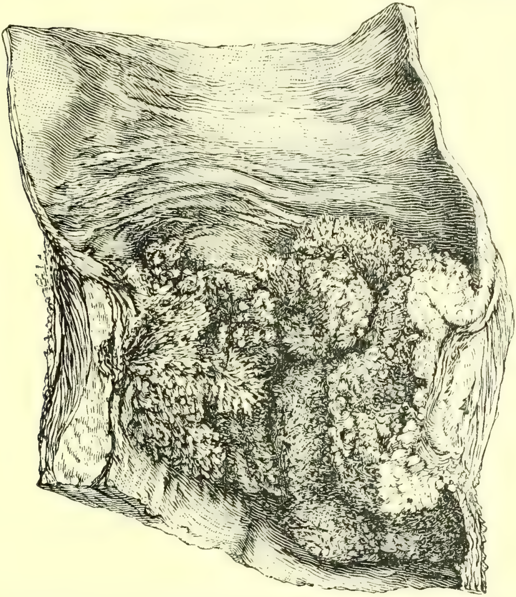

FIG. 345.—Columnar or adenoid carcinoma of the rectum, from a man aged 64 years. (St. Bartholomew's Hospital Museum, No. 2,069 *a*.)

down, by the absence of induration, by the discharge being thin and mucoid, the blood bright and small in quantity, and the rectum not fixed, and by the duration of the disease. A *fibrous stricture* may be known by its long duration, by being less indurated than the cancerous form, by the bowel not being fixed, and when due to syphilis, by the absence of a healthy strip of mucous membrane between the growth and the anus.

Treatment.—If the disease is seen sufficiently early and before it has involved the surrounding parts, if it is not situated too high up the rectum, and if the general condition of the patient is otherwise favourable, excision of the growth with the lower end of the rectum should be undertaken, as in this way the whole may be removed, and not without reasonable hope, in some of the less malignant forms of the disease, of its not returning. Some cases have been reported where it has not done so for upwards of four years. Previous to removal of the rectum, I now invariably perform inguinal colotomy, since after this operation there is less risk of the wound left by the excision becoming septic. Where removal seems impracticable, or otherwise unadvisable, such palliative measures should be adopted as may render the last few months or years of the patient's life as comfortable as possible. Thus the bowels should be kept gently relaxed, the diet regulated, and the pain relieved by morphia suppositories. In this way the patient can often follow his occupation in comparative comfort and with little inconvenience. Should, however, there be very frequent calls to defæcate, much pain and irritation on the passage of fæces, or obstruction threaten or have already occurred, colotomy should be performed (p. 626). This operation should not, as is too frequently the case, be regarded merely as a last resource, to be undertaken when obstruction has come on, as then the danger of the operation is greatly increased. Nor should it be undertaken in every instance, since the inconvenience caused by the cancer is not always sufficient to justify the patient undergoing the risk.

Excision of the rectum may be performed if the finger can be passed beyond the growth; if the growth is moveable; if the glands are not involved, and if the patient is otherwise fairly healthy. The patient having been placed in the lithotomy position and a staff introduced into the bladder, a curved bistoury should be passed along the finger up the rectum, and its point made to emerge near the coccyx, and the intervening tissues cut through in the middle line. By this incision a free exposure is obtained. Lateral incisions are next made on each side of the anus, meeting in front, the levatores ani divided, and the bowel rapidly cleared either with the finger or with the handle of the scalpel from the tissues of the ischio-rectal fossa. The lower part of the rectum is now dissected more carefully from the urethra and prostate, and when it has been sufficiently freed, the écraseur is placed above the growth, and the rectum removed, care being taken that the cord when tightened is not pulled down below the spot where it is intended to sever the bowel. If preferred the scissors may be substituted for the écraseur, the vessels being then tied as they are cut. When the growth does not involve the whole of the bowel, a strip of mucous membrane should, if possible, be left. The rectum should now, if possible, be drawn down and sutured to the skin by four deep sutures passed under the divided pelvic structures. The gut should be plugged with iodoform gauze for a week if possible, a tube being placed through the gauze to allow of the escape of flatus. *Kraske's operation* for removing the rectum consists in making an incision from the anus to the middle of the sacrum; freeing the sacrum from the muscles and ligaments, dividing it at level of third sacral foramen, and removing the lower part of the bone. The whole rectum can be explored up to the sigmoid flexure and removed as necessary. By some the sacrum is split in the middle line below the transverse section, and each half separated and replaced after the rectum has been removed.

DISEASES OF THE URINARY ORGANS.

SURGICAL DISEASES OF THE KIDNEYS.

NEPHRITIS, or inflammation of the kidney, as met with in surgical practice, is commonly the result of long-standing disease of the bladder, urethra, or prostate, or of the impaction of a calculus in the ureter or pelvis of the kidney. Traumatic nephritis has already been alluded to under *Injuries of the Abdomen*.

The inflammation, when secondary to other diseases of the urinary organs, may be produced in several ways. Thus, it may be due to —1. Tension in the tubules of the kidney, resulting from obstruction to the overflow of urine consequent upon long-standing stricture of the urethra or prostatic enlargement. Under these circumstances the inflammation falls chiefly on the cortical and medullary substance of the kidney (*interstitial nephritis*). 2. The presence of septic matter in the pelvis of the kidney due to (*a*) the spread of inflammation up the ureter from the bladder, or (*b*) decomposition of pent-up urine behind an impacted calculus in the ureter or pelvis of the kidney. In this case the inflammation is of a septic or suppurative character, and although it may chiefly affect either the lining membrane of the pelvis (*pyelitis*) or the substance of the organ (*suppurative nephritis*), it more generally involves both (*pyelo-nephritis*). At times the pelvis and calices become distended with the pus, and the kidney is finally converted into a suppurating cyst (*pyo-nephrosis*). 3. Reflex irritation of the kidney through the nervous system, as from the passage of a catheter in stricture or enlarged prostate, or the performance of some operation on the urinary organs, as lithotomy or lithotrity. Here the inflammation is usually transitory, unless the kidneys are already suffering from the effects of urinary obstruction, when it may run on to suppuration.

Simple interstitial nephritis usually begins in an insidious manner, the *symptoms* of the kidney mischief being obscured by the primary affection of the urinary organs from which the patient is probably suffering. It may be suspected, however, where there is continual loss of strength, increasing pallor and gradual wasting. The urine is passed in large quantities, and is of low specific gravity. Albumen at first is absent, or only present in small quantities, and although later it may be increased in amount, it is often difficult to estimate in consequence of the pus, mucus, or blood which may be present, owing to the diseased bladder or other urinary trouble. Should these troubles not be relieved, the symptoms of the kidney affection become more marked; there is loss of appetite, a furred tongue, nausea, perhaps vomiting, increase of temperature at nights, a hot skin, thirst, and emaciation. This condition may last for months, when the symptoms may gradually subside if the primary trouble can be removed; or it may terminate in exhaustion and death; or in an acute attack of suppurative nephritis.

The *treatment* consists essentially in removing the cause, where this is practicable, and carefully avoiding all sources of irritation that may react through the nervous system of the kidney. Thus, all instrumentation must be done in the gentlest possible manner, and decomposition of the urine prevented by washing out the bladder with antiseptic solutions. The patient at the same time should be kept in bed, and restricted to a non-stimulating and chiefly fluid diet; whilst hot flannels and occasionally dry cups should be applied to the loins.

Suppurative or septic nephritis.—Under this head is included suppuration of the pelvis and of the substance of the kidney, since both, as a rule, are simultaneously affected, and the symptoms are similar or identical. Pyonephrosis is considered separately. Suppurative nephritis generally occurs suddenly in the course of long-standing disease of the lower urinary organs, attended with septic decomposition of the urine in the bladder. It is probably almost always due to the septic micro-organisms reaching the kidneys from the bladder by the ureters. It is usually preceded by simple interstitial nephritis.

The *symptoms* which frequently first come on after some operative procedure on the urethra or bladder, are usually ushered in by a rigor followed by sweating and fever. The tongue becomes dry and red; the lips and teeth are covered with sordes; the appetite is lost; nausea, vomiting, or diarrhœa sets in, and the patient usually sinks into a typhoid state and dies. There is no œdema, and the urine usually continues abundant and loaded with pus to the end, though it may at times be diminished in quantity or even suppressed. It may or may not contain blood.

Treatment as a rule is of little avail; but the same general plan should be followed as described under simple interstitial nephritis. Where the cause can be effectually removed, recovery may at times take place.

Circumscribed abscess may occur in the kidney substance or in the cellular tissue around (*peri-nephritic abscess*). It must be distinguished from pyonephrosis, in which the pelvis and calices are distended with pus. *Cause.*—It is generally due to injury, pyæmia, or renal calculus. When it occurs in the peri-renal tissue, it may be consecutive to abscess or other disease of the kidney itself; or it may be due to causes independent of the kidney, as cold, disease of the spine, and other conditions leading to the formation of abscesses. The *symptoms* are those of deep suppuration, attended with certain peculiarities on account of its situation, which, however, cannot be here discussed. The *treatment* consists in making a free incision into the abscess through the loin.

Hydronephrosis is an over-distension of the pelvis of the kidney with altered urine. *Cause.*—Any condition in the bladder, ureter, or pelvis of the kidney, producing mechanical obstruction to the outflow of urine. These conditions may be divided into the *congenital*, such as twists of the ureter, smallness of its vesical orifice, phimosis (Fig. 346), &c., and into the *acquired*, such as impaction of a calculus in the ureter, enlarged prostate, stricture of the urethra, &c. *Pathology.*—The pelvis, and subsequently the calices of the kidney, become distended with urine, the cortical substance is destroyed by the pressure of the retained urine, and the whole organ finally converted into an irregular cyst (Fig. 346). The hydronephritic fluid consists of altered urine, and may contain hardly a trace of urea. *Symptoms.*—When the obstruction is complete, a tumour is found in the abdomen, and often attains a great size. It may then be mistaken for an ovarian cyst, an hydatid cyst of the liver or omentum, a distended gall-bladder, a splenic tumour, a solid tumour of the kidney, or pyonephrosis. From these a hydronephrotic kidney may generally be distinguished by the colon being in front of it, by the presence of fluctuation, by its dulness to percussion, by its situation in the flank, by its projection more or less in the loins, by the uterus being free and not displaced, and by the absence of febrile symptoms. *Treatment.*—Aspiration, unless the tumour is small and painless, when it may be left alone, should first be tried; but if the fluid rapidly reaccumulates, nephrotomy will usually be required.

PYONEPHROSIS is the distension of the pelvis and calices of the kidney with pus, and the subsequent destruction, more or less complete, of the medullary and cortical substance, the whole kidney being at length converted into a large multilocular cyst. This cyst may rupture into the peritoneal cavity or colon, or into the surrounding tissue, causing a perinephritic abscess. *Causes.*—It may follow pyelitis, owing to the blocking of the ureter with a clot of blood or pus; or it may be engrafted on hydronephrosis, consequent upon tapping or injury. At times it may be the result of tubercle, or of a direct injury of the kidney. *Symptoms.*—In addition to a tumour in the abdomen with characters similar to those of hydronephrosis, there will be pain in the tumour, especially on pressure, febrile disturbance, and if the obstruction of the ureter

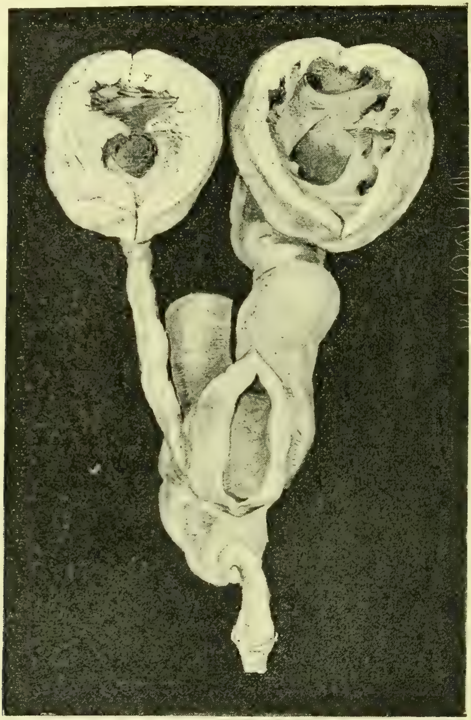

FIG. 346.—Hydronephrosis, with dilated ureters, bladder and penis, due to phimosis in an infant aged five months. (St. Bartholomew's Hospital Museum, No. 2370 *b*.)

is incomplete, pus in the urine from time to time. *Treatment.*—Having aspirated the tumour, and discovered the presence of pus, nephrotomy is generally indicated, especially if the tumour rapidly refills, and if there is much pain or febrile disturbance, or rupture of the cyst appears imminent. If, after nephrotomy, however, the cyst does not shrink and cease to suppurate, nephrectomy must be done, as otherwise lardaceous disease or hectic may carry off the patient, or blood-poisoning may ensue from the discharge becoming septic, or, as sometimes happens when the obstruction of the ureter is relieved to some extent by the nephrotomy, the decomposing pus may make its way into the bladder, set up cystitis, and the other kidney become affected. Under some circumstances, as where the kidney is reduced to little more than a shell, it will be better at once to perform nephrectomy.

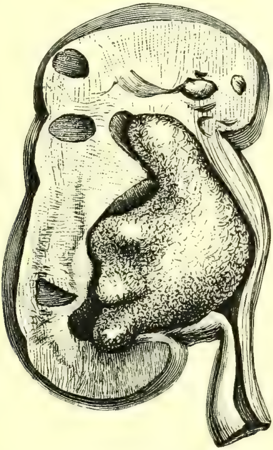

FIG. 347.—Renal calculus blocking up pelvis of kidney and commencement of ureter. (St. Bartholomew's Hospital Museum.)

RENAL CALCULI generally consist of uric acid or of oxalate of lime, and are formed by the deposit of the urinary salts, either in the tubules or calices of the kidney. Whilst still small, they may pass down the ureter into the bladder, and subsequently form the nucleus of a vesical calculus, or be voided with the urine. Or they may remain in the kidney, either in its substance, or in the pelvis or one of the calices, and there increase in size by the successive deposit upon them of the urinary salts. They may be single or multiple, and vary in size and shape from a small rounded body the size of a mustard-seed to a large branched mass filling the pelvis and calices (Fig. 347). Their presence may set up inflammation of the pelvis of the kidney (*calculous pyelitis*), or of its substance (*simple or suppurative nephritis*). Or they may block the ureter, in which case the kidney may become distended with altered urine (*hydronephrosis*), or with pus (*pyonephrosis*); whilst at times, they may exist for years, causing little or no damage. Not infrequently there may be a stone in both kidneys.

Symptoms.—At times there may be no symptoms, even although the stone is of large size. Generally, however, there will be pain, retraction of the testicle, increased frequency of micturition, and the presence of blood, pus, or crystals in the urine. The pain, which is worse after exercise, is usually situated in the loin of the affected side, and is often felt shooting down the course of the ureter to the groin and front of the thigh, but it may be felt in both loins or may shift from one side to the other. Blood is generally present in the urine from time to time, especially after violent exercise, and pus and mucus in varying quantities if pyelitis has been set up may also, as a rule, be detected. The urine, notwithstanding the presence of the pus, is generally acid, and the bladder, prostate, and urethra are found free from disease. Should hydronephrosis or pyonephrosis have been produced, a tumour will then be discovered in the abdomen, and there may no longer be any pus or blood in the urine. In the latter instance there may be in addition constitutional signs of suppuration (see *hydro-* and *pyonephrosis*). Should the stone escape from the pelvis and enter the ureter, its passage down that tube will be attended with intense pain (*renal colic*). The pain occurs suddenly and darts towards the groin, testicle, and thigh, and is accompanied by nausea or vomiting, syncope, profuse perspiration, and blood and urates in the urine. After lasting from a few hours to several days the symptoms suddenly cease, owing to the calculus dropping from the lower end of the ureter into the bladder, or if too large to pass beyond the infundibulum, becoming displaced into the pelvis of the kidney. Hence successive attacks of renal colic may be due either to the same stone blocking up from time to time the entrance of the ureter or to the passage of different stones. It is often difficult to determine which kidney is affected since pain may be felt in both loins. In doubtful cases each kidney should be explored with the hand passed through an incision in the front wall of the abdomen.

Treatment.—For an account of the preventive treatment a work on medicine must be consulted. When a stone has formed and medical treatment has failed to give relief after long-continued trial, and the patient's life is rendered unbearable from constant pain or compulsory recumbency, an operation must be undertaken for his relief. This may consist in nephrolithotomy, nephrotomy, or nephrectomy. Where the kidney is but little if at all damaged the first is clearly indicated; but if, on exploring the kidney, the stone cannot be felt even on puncture with a needle, or on incision and exploration with the finger, it becomes a question whether nephrectomy should be done, or the kidney left *in situ* and the wound merely closed. The latter procedure is generally the best, since after exposure of the kidney, though no stone is found, the patient often gets relief. If hydronephrosis or pyonephrosis has supervened, nephrotomy is required, or possibly nephrectomy. For renal colic, hot baths, hot fomentations, and opium or injections of morphia must be given to assuage the pain.

THE TUBERCULOUS KIDNEY (Fig. 348) need only briefly be referred to here, as it is more fully described in works on Medicine. This affection may occur in the course of general tuberculosis, or involve the kidney secondarily to the bladder or prostate; or it may begin primarily in the kidney and thence spread downwards. The *symptoms* to which it gives rise are very similar to those of renal calculus, and it may be impossible to distinguish them. Thus, there is increased frequency of micturition; pus, and at times blood, in the urine, and often pain in the loin; whilst later there will be a tumour in the abdomen with characters like those described under pyonephrosis. The presence of tubercle elsewhere, and of hectic

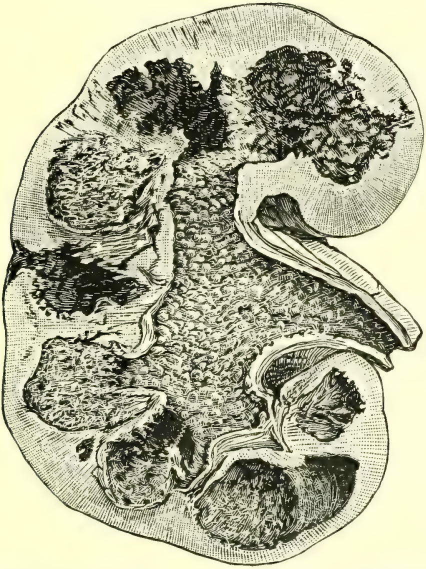

FIG. 348.—Tuberculous disease of kidney. (St. Bartholomew's Hospital Museum, No. 2341 *f.*)

or emaciation, and the discovery of the tubercle bacillus in the urine, will point to the nature of the case. *Treatment.*—The constitutional remedies for tubercle should be employed, and when pyonephrosis or a perinephritic abscess has formed, nephrotomy may be resorted to. When the tuberculous deposits are limited they may be cut or scraped away, iodoform emulsion applied, and the cut surfaces sutured. Nephrectomy should never be undertaken unless it seems clear that the disease is limited to one kidney, the exception rather than the rule, and a point that can only be ascertained with certainty by exploration through the front wall of the abdomen.

CYSTS OF THE KIDNEY.—Serous and hydatid cysts may occur in the kidney as elsewhere, but the question of their diagnosis, which is often attended with much difficulty, cannot be discussed here. They are very rare. Cysts of small size are common in connection with some forms of chronic Bright's disease; but these only concern the pathologist. The so-called cystic degeneration, due to urinary obstruction, pyelitis, pyonephrosis, &c., has already been alluded to.

TUMOURS OF THE KIDNEY.—Sarcoma and carcinoma are the only tumours which need be referred to. They are characterized by a swelling in the region of the kidney, dulness in the flank, the presence of the colon in front of them, the absence of fluctuation unless they are of a cystic character, blood in the urine, and rapid emaciation. *Treatment.*—If the tumour is diagnosed whilst still small, nephrectomy may be done, though an early recurrence is only too probable. When the tumour is of large size and has formed adhesions to the neighbouring parts, it is beyond the reach of legitimate surgery. It has recently been proposed, where the tumour only involves a part of the kidney, to save the healthy portion. That such an operation is practicable is well shown in Fig. 349, but seeing how rapidly recurrence takes place, even when the whole kidney is removed, I fail to see any advantage in a partial removal.

SUPPRESSION OF URINE is the term applied to the non-secretion of urine by the kidneys, and must not be confounded with *retention* of urine, in which the urine is secreted as usual, but its passage from the bladder is obstructed. In the former the bladder is empty; in the latter distended. Suppression as met with in surgical practice is generally due to the shock following an operation or injury on the urinary organs in a patient suffering from chronic renal disease. If not relieved, coma, convulsions, and death from uræmia quickly ensue. *Treatment.*—Dry or wet cupping the loins, hot vapour baths, free purging as by elaterium or croton oil, injections of pilocarpine, and hot enemata per rectum, are at times successful in relieving the congested kidney.

Operations on the Kidney.

Aspiration of the kidney may be performed either for the purpose of diagnosing a renal swelling, or for the relief of such affections as hydronephrosis, pyonephrosis, or hydatid or blood cysts. It should be done with the ordinary precautions, any prominent or fluctuating spot being chosen for the puncture.

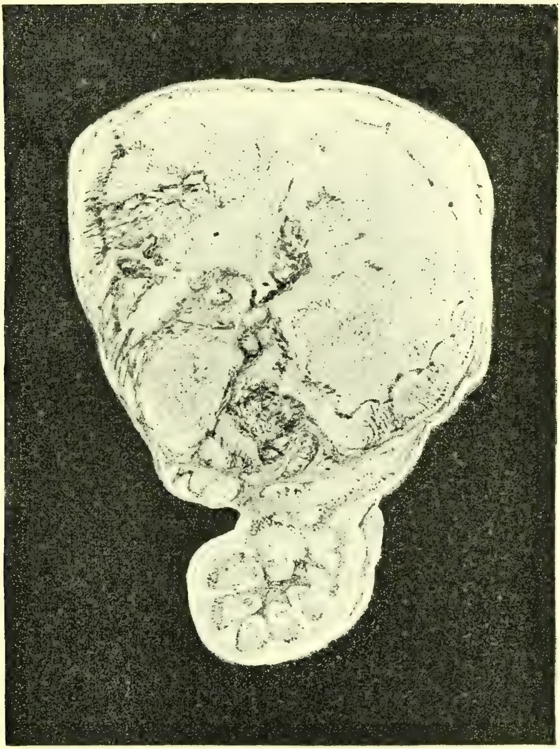

Fig. 349.—Sarcoma of kidney. The growth, which microscopically is a round celled sarcoma, only occupies the upper half of the kidney; the lower half of the organ is free. It was removed from a woman aged 27 years, but recurred within a few months. (St. Bartholomew's Hospital Museum, No. 2391 *b.*)

Nephrotomy consists in making an incision into the kidney for the purpose of evacuating and draining the fluid or pus in the case of hydronephrosis, pyonephrosis, hydatid cyst, abscess, &c. The tumour may be exposed by the lumbar or lateral incision as described in nephrectomy. An incision is made into the kidney, the fluid allowed to run out, the wound thoroughly irrigated with some antiseptic solution and insufflated with iodoform, a large-sized drainage-tube inserted into it, and voluminous dressings of absorbent gauze or the like applied to receive the subsequent discharges.

NEPHRO-LITHOTOMY consists in cutting into a kidney for the purpose of extracting a calculus. The kidney may be exposed either by the lumbar or lateral incision as described in nephrectomy. If a stone is felt, an incision should be carefully made over it, the finger or forceps introduced, and the stone extracted. If one cannot be felt, a needle should be thrust into the kidney at several situations, and this failing, an incision should be made into it, and the finger and a probe introduced to search for the stone. A drainage-tube should be placed in the wound, and an antiseptic and absorbent dressing applied. The urine will at first escape through the wound, but will cease to do so, as a rule, after a longer or shorter interval.

NEPHRECTOMY, or removal of the kidney, may be done for—1. A large renal calculus. 2. Tuberculous disease with exhausting discharge. 3. Hydronephrosis. 4. Malignant and other tumours. It has also been done for—5. Moveable kidney attended with severe neuralgic pain, but for such nephrorrhaphy should be first tried. The operation may be done without opening the peritoneum either by a lumbar or a lateral incision, or through the peritoneal cavity, the incision being then made either in the linea alba or linea semilunaris. Before removing a kidney the surgeon should make sure that a kidney exists on the opposite side, and is fairly healthy. This may be ascertained in some measure by estimating the amount of urea secreted, by passing a catheter into the ureters in females and collecting and testing the urine thus obtained, or better, by exploring from the front through an abdominal incision.

The *extra-peritoneal operation.*—If the incision is made in the lumbar region it may be vertical, T-shaped, or oblique like that of colotomy. If the lateral incision is chosen it should be made obliquely from near the tip of the last rib, towards the anterior superior spine of the ilium. It is the one I have always employed myself, and one now in common use at St. Bartholomew's, its advantages being that it combines the facilities of the intra-peritoneal and the greater safety of the lumbar incision as it does not involve opening the peritoneal cavity. The kidney having been exposed by any of these incisions, the capsule should be opened, the finger introduced, and the kidney enucleated from its capsule; the renal artery and vein should then be securely tied with a silk ligature passed round them by an aneurysm-needle, and the ureter secured separately in a similar way. The kidney may now be removed by cutting through the pedicle with scissors, and the wound drained and dressed antiseptically.

The *intra-peritoneal operation.*—This consists in opening the peritoneal cavity by one of the incisions mentioned above, drawing the intestines aside, and then exposing the kidney by cutting through the peritoneum in front of it external to the colon. The vessels are then tied separately, the kidney removed, and the peritoneum united, the same precautions being adopted as after an ovariotomy. A drain-tube is passed by some surgeons through a counter-opening in the loin, and the end of the ureter brought out of the wound.

The *dangers of nephrectomy* are—1. Severe shock. 2. Excessive hæmorrhage. 3. Suppression of urine from disease or absence of the opposite kidney. 4. Peritonitis from wounding the peritoneum. 5. Laceration of the colon. 6. Inclusion of the vena cava in the ligature of the pedicle and injury of the duodenum in operating on the right side.

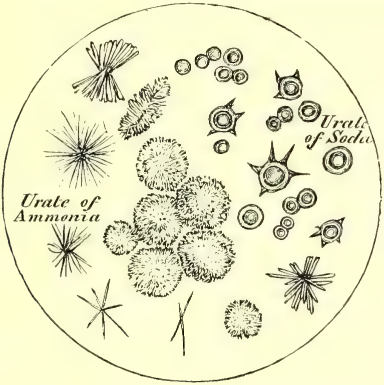

Fig. 350.—Urates. (Bryant's Surgery.)

Nephrorrhaphy is an operation for fixing a floating or moveable kidney by exposing the kidney in the loin, and attaching it with sutures, passed through the capsule, to the parietes. It should only be done where there is much pain and constant suffering which palliatives, such as wearing a supporting belt, have failed to relieve.

Urinary Deposits and Calculi.

Urinary deposits are divided into the unorganized and the organized. A. The *unorganized* consist of the urates, the uric acid, the oxalate of lime, the phosphates, the cystic oxide, the uric oxide and the carbonate of lime. Only the more common of these are described.

1. The *urates* formerly called *lithates*, are the most common of the urinary deposits, and are formed by the combination of uric acid with ammonia, soda, or lime. They occur in acid urine as an amorphous sediment, varying in colour from a white or a pale fawn to a brick-dust red. They only appear as the urine cools, and disappear again on the application of heat, or on adding alkalies. Though generally amorphous they sometimes present the crystalline forms seen in Fig. 350. The urate of ammonia occurs in alkaline urine.

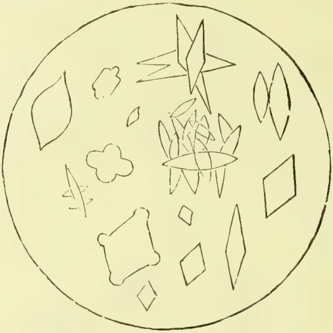

Fig. 351.—Uric acid crystals. (Bryant's Surgery.)

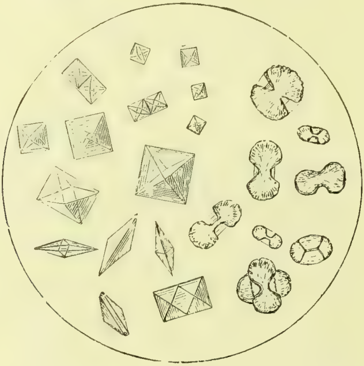

Fig. 352.—Crystals of oxalate of lime. (Bryant's Surgery.)

2. The *uric acid* deposits, which are the next most common, occur

only in very acid urine, as a yellowish-pink, red, or brick-dust red crystalline sediment. The crystals are often of large size, and the deposit is then known as *red sand* or *gravel*. They usually occur as rhombic prisms, or long oval plates with acute angles, and are often mixed, forming rosettes. The various kinds are seen in Fig. 351. They are soluble in alkalies. The *causes* of the presence of uric acid, as well as of the urates, are:—1. Rapid tissue waste, as in fevers; 2. Over-indulgence in animal food; 3. Dyspepsia; 4. Congestion of the kidney; 5. Gout; and 6. Deficient action of the skin.

3. The *oxalate of lime* is a crystalline deposit and assumes two forms, the octahedral and the dumb-bell crystals (Fig. 352). On holding the urine up to the light the crystals are seen in it as minute shining particles. The *causes* are:—1. Nervous exhaustion from overwork or sexual excesses. 2. Dyspepsia induced by saccharine food, excess of alcohol, or vegetable diet.

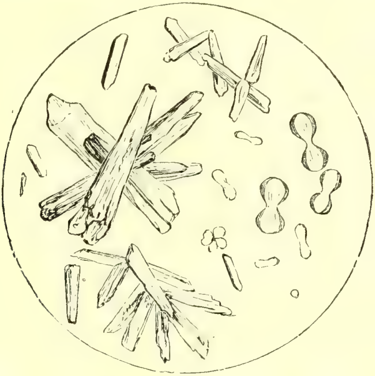

Fig. 353.—Phosphates of lime. (Bryant's Surgery.)

4. *Phosphatic* deposits occur in three forms, (*a*) phosphate of lime, (*b*) phosphate of ammonia and magnesia, or triple phosphates, (*c*) the two former mixed, or the fusible phosphates. (*a*) *Phosphate of lime* forms a white cloud or amorphous deposit of pale granules or spheroids, two of which adhering form the so-called false dumb-bell; or a crystalline deposit of six-sided prisms collected into sheaths or bundles (Fig. 353). It may be mistaken for albumen, or when in considerable quantities for pus or mucus. The urine is usually alkaline, but may be neutral or even feebly acid. (*b*) The *ammonio-magnesium phosphates* occur in the form of large triangular prisms with truncated extremities; as four-sided prisms; as six-sided plates; and as foliaceous stellar prisms on adding ammonia (Fig. 354). The urine is natural in colour, neutral or alkaline, with

a fœtid ammoniacal odour. *Causes.*—Phosphatic deposits are due to local disease or injury of the urinary organs, such as may be induced by spinal mischief, a foreign body in the bladder, &c. The mucus or bacteria in the bladder, decompose the urea into carbonate of ammonia, which converts the soluble acid phosphates into insoluble alkaline phosphates.

Carbonate of lime, *cystic oxide*, and *uric oxide*, are too rare to require description.

B. *The organized deposits.*—To these belong pus, blood, mucus, epithelium, renal casts, spermatozoa, and fungi. *Pus* occurs as a thick sediment, and may be recognized by the urine containing albumen, and by the microscopical appearance of the pus corpuscles (p. 22). It may be due to cystitis, pyelitis, gonorrhœa, leucorrhœa, and abscess in any part of the urinary tract. Urine containing *mucus* becomes gelatinous and ropy on adding liquor potassæ. *Blood* may be recognized by the urine being smoky or red, by the ozonic ether test, and by the microscope and spectroscope. See *Hæmaturia* (p. 722). *Epithelium*, *renal casts*, *spermatozoa*, and *fungi* may be detected by the microscope.

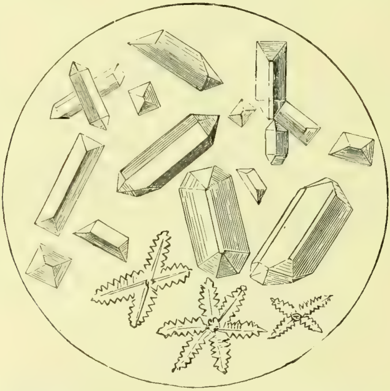

FIG. 354.—Phosphates of ammonia and magnesia (triple phosphates). (Bryant's Surgery.)

URINARY CALCULI are commonly spoken of as renal, vesical or prostatic, according as they occur in the kidney, bladder or prostate. *Renal calculi* are formed in the kidney, and have already been described (p. 691). *Prostatic calculi* are formed in the racemose glands of the prostate, and will be further referred to under diseases of that organ (p. 726). *Vesical calculi* may originate in the bladder, or, as is more commonly the case, in the kidney, whence they pass into the bladder, and there increase in size by the successive deposit upon them of the same or other of the urinary salts. The calculi most frequently met with in this situation are (1) the uric acid, (2) the oxalate of lime, and (3) the fusible or mixed phosphates. The rarer forms are (4) the urate of ammonia; (5) the cystic oxide or cystine; (6) the phosphate of lime; (7) the phosphate of ammonia and magnesia, or triple phosphate; (8) the carbonate of lime; (9) the xanthic or uric oxide; (10) the fibrinous; (11) the blood; (12) the uro-stealith; and (13) the silicious. The last seven being exceedingly rare are not described.

1. The URIC ACID CALCULI are the most common. They are generally of moderate size, oval, and laterally compressed, of a nut-brown colour, smooth or finely granular, moderately heavy and hard, and laminated on section. They are completely destroyed in the blow-pipe flame, giving off a smell of burnt feathers. They are insoluble in weak hydrochloric acid, but soluble in warm alkalies. When treated by nitric acid and evaporated to dryness, on the addition of a drop of ammonia a purple colour is produced (*murexide test*). The nucleus is generally composed of uric acid, sometimes of oxalate of lime, and is generally formed in the kidney. These calculi occur most frequently in *youth* and *middle age*.

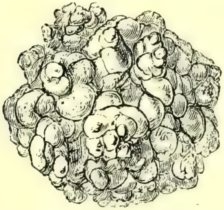

FIG. 355.—Oxalate of lime calculus.

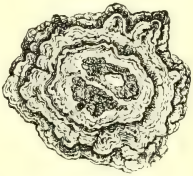

FIG. 356.—Section of oxalate of lime calculus.

2. THE OXALATE OF LIME, OR MULBERRY CALCULI (Figs. 355, 356), as they are often called from their resemblance, when first removed covered with blood from the bladder, to a mulberry, are generally of moderate size, globular in shape, usually of a dark-brown or mahogany colour, rough and tuberculated, very hard and heavy, and crystalline on section. They are only partially destroyed in the blow-pipe flame, the residue being alkaline and effervescing with an acid. They are insoluble in acetic acid, but soluble in hydrochloric acid. The nucleus is generally composed of oxalate of lime, but may consist of uric acid or urate of ammonia. The nucleus is usually formed in the kidney. These calculi are most frequent in *middle age*.

3. THE PHOSPHATIC CALCULI are of three kinds:—(*a*) the phosphate of lime or earthy phosphate; (*b*) the ammonio-magnesian or

triple phosphate, and (*c*) the phosphate of lime with the ammonio-magnesian phosphate, the mixed or fusible phosphate. Of these the last is the only common form. It is usually of large size and of white colour, smooth, soft, friable, earthy and laminated on section, and of irregular shape, taking that of the nucleus on which it is formed; it fuses when heated in the blow-pipe flame; is insoluble in warm alkalies, but is soluble in acetic acid. The nucleus is composed of uric acid, oxalate of lime, or of some foreign body other than a calculus, as a piece of catheter, hair-pin, blood, or fibrin. It occurs most frequently in the *later* periods of life, and is then generally produced as follows:—A calculus or other foreign body irritates the mucous membrane of the bladder, and a secretion of mucus is, in consequence, poured out. This mucus decomposes the urea contained in the urine into carbonate of ammonia and water. The carbonate of ammonia unites with the acid phosphates, and an insoluble mixed phosphate of ammonia, magnesia and lime is thrown down and deposited on the foreign body. Hence these calculi are only met with in alkaline conditions of the urine.

Although calculi may be chiefly composed of one constituent, they are more often composed of several, which may be arranged in alternate layers (*alternating calculus*). The formation of these layers is due to the varying state of the patient's health and of the condition of the mucous membrane of the bladder.

DISEASES OF THE BLADDER.

EXTROVERSION OR ECTOPIA VESICÆ is a malformation in which, in consequence of an arrest in the development of the anterior wall of the bladder and the corresponding part of the abdominal parietes, the posterior wall of the bladder is pushed forward by the pressure of the abdominal viscera, and protrudes as a red velvety tumour. It is associated with epispadias, or absence of the upper wall of the urethra, and with failure of union of the pubic bones at the symphysis. The testicles are frequently retained in folds like the labia on either side. It is attended with extreme discomfort from the constant dribbling away of the urine from the mouths of the ureters, which can be seen on the surface of the tumour. *Treatment.*—Many operations having for their object the closing in of the bladder by flaps of skin taken from the adjacent abdominal wall, have been performed for the relief or cure of the deformity. Various attempts have also been made to turn the ureters into the colon or rectum, but without success. Recently Trendelenberg has succeeded in reducing the gap between the pubic bones by separating the sacro-iliac synchondroses, so that he was enabled at a subsequent sitting to bring the margins of the mucous surface of the bladder in contact, and then unite them by a plastic operation. The newly-formed bladder is in this way lined with mucous membrane instead of having its front wall closed in by skin. The objection to the skin flap is the growth of hair into the bladder at puberty and its incrustation with phosphates. If no operation is undertaken a properly-shaped urinal must be worn.

CYSTITIS, or Inflammation of the Bladder, may vary from the mildest catarrh to the most intense inflammation, involving not only the mucous membrane but the other coats of the organ as well. For the purpose of description, however, it may be divided into the Acute and Chronic.

ACUTE CYSTITIS.—*Causes.*—In its most intense form it is nearly always the result of injury or operation, as the passage of instruments, irritation of sharp fragments of a crushed calculus, &c. In its milder forms it may be due to the extension of inflammation from the urethra as in gonorrhœa, or from the ureters in calculous pyelitis; to the exhibition of certain medicines, as cantharides; and occasionally in gouty subjects to exposure to cold,

Symptoms.—In the acutest forms there is intense pain, and strangury, *i.e.*, a continual desire to void urine, which is passed drop by drop in a spasmodic manner; whilst there is high fever, rapidly running into a typhoid type. In the less acute or more common forms micturition is still very frequent, with increased pain, as soon as a little urine has collected in the bladder, in consequence of the stretching of the inflamed mucous membrane. The urine is scanty, high-coloured, often blood-stained, and mixed with mucus and pus. The fever, though generally high, is less marked than in the acuter cases, and may be of a mere transitory character.

Pathology.—In the milder forms the inflammation is limited to the neck of the bladder and to the mucous membrane only. In the worst forms it involves the whole bladder, and extends to the muscular or even the peritoneal coat. It may terminate in 1, resolution; 2, chronic cystitis; 3, ulceration or gangrene of the mucous membrane; 4, abscess in the walls of the bladder; 5, inflammation of the kidneys, or more rarely of the peritoneum; and 6, sapræmia, produced by the absorption of the products of the decomposing urine.

Treatment.—The cause, if possible, should be removed. Thus, if there are fragments of calculus in the bladder, they should at once be extracted by the large evacuating catheter, any that cannot be got away being crushed; or perhaps better, the bladder may be opened by a median incision in the perineum and thoroughly washed out. If a catheter has been tied in, it should at once be withdrawn. Hot sitz-baths should be given night and morning, leeches applied to the perineum, suppositories of morphia placed in the rectum, and salicylate of soda, hyoscyamus, and alkalies if the urine be acid, administered to relieve strangury. All stimulants should be avoided, the diet restricted to milk, and the bladder washed out with hot water, or when the urine is decomposed, with a weak antiseptic lotion as boric acid, salol, &c. If washing out increases the irritation, the bladder in severe cases should be drained by an incision in the perineum.

CHRONIC CYSTITIS is much more frequent than the acute variety, and in its mildest form is known as catarrh of the bladder. *Causes.*—It may be a sequel to an acute attack; or it may be chronic from the commencement, and may then be due to a stone or other foreign body or a growth in the bladder, obstruction to the urinary outflow, as from an enlarged prostate or stricture of the urethra, the extension of gonorrhœa, paralysis, over-distension or atony of the bladder, or the spread of inflammation from the neighbouring organs.

The symptoms are similar to those of acute cystitis, but are much milder in intensity. Thus, there is increased frequency of micturition, the patient, perhaps, having to make water every hour or half-hour, the desire to do so being generally so urgent that he is unable to control it. This, as in the acute variety, is due to the stretching of the inflamed mucous membrane as soon as a few ounces of urine collect. The pain usually ceases immediately the bladder is relieved. The urine is characteristic; it generally contains large quantities of ropy mucus and pus, which form, on standing, a distinct layer at the bottom of the containing vessel. It is often alkaline, and sometimes highly ammoniacal and offensive from the decomposition of the urea into carbonate of ammonia. This decomposition is brought about by fermentation, probably set up by the presence of micro-organisms (*Micrococcus ureæ*) that have gained admission either by the use of a contaminated catheter, or by making their way along the stringy mucus that may hang about the urethra. *Pathology.*—The mucous membrane is thickened, velvety, mottled with patches of a dark-slate or red colour, and may be covered with muco-pus and sometimes with a deposit of phosphates, or it may even, in places, be destroyed by ulceration. The muscular coat, where there has been obstruction to the outflow, becomes thickened and fasciculated, the hypertrophied fibres giving the interior of the bladder a columnar and rugose appearance. In places the mucous membrane may protrude between the fasciculi of the muscular coat, forming sacculi which may become receptacles for urine, and in which calculi may form. If the cystitis is allowed to continue, the kidneys may subsequently become affected.

Treatment.—As in the acute form the cause, as stricture, stone, &c., must first be removed, as where this is impracticable the treatment at best can only be palliative. The diet should be unstimulating, and alcohol in any form, as a rule, forbidden. A purely milk diet is at times most successful. Internally, such medicines as buchu, uva ursi, balsam of copaiva, salol and chlorate of potash should be given where thick ropy mucus is passed with the urine; and benzoic acid, which in its passage through the system is converted into hippuric acid, may be tried when the urine is alkaline. Locally, the bladder should be washed out twice a day with some antiseptic solution, as boric acid, nitric acid, corrosive sublimate, quinine, &c. The best results are sometimes obtained from water as hot as can be borne. Great care should be taken that all instruments are rendered thoroughly aseptic before use. In severe cases, where other means have failed, the bladder should be placed at rest by perineal cystotomy and subsequent drainage for some weeks.

Irritability of the bladder, by which is meant a too frequent passing of water, is often spoken of as a disease; but is no more so than is pain, since it is only a symptom either of disease of the urinary organs, or of some general state of the system, as hysteria, Bright's disease, &c. The cause should be sought and treated.

Inversion of the bladder, and hernia of the bladder, are both very rare, and are not here described.

Atony and paralysis of the bladder. Both these terms are applied to a want of sufficient contractile power in the muscular coat to expel the contents of the bladder; but in *atony* the want of power is the result of loss of tone in the muscular fibres, while *paralysis* is due to the failure of nervous influence. Both conditions must be distinguished from the mere inability of the bladder to empty itself on account of obstruction to its outlet. (See *Retention.*)

Atony may be due to—1. Simple over-distension, consequent upon the patient having voluntarily or compulsorily held his urine for too long a period, whereby the muscular fibres are overstretched and unable to recover themselves. 2. It may be the result of gradual distension owing to enlarged prostate or stricture. In consequence of the obstruction, the bladder does not empty itself, but some urine remains after every act of micturition; the amount retained gradually increases, the bladder becomes distended, and its fibres, if the patient is old, become stretched, and lose their tone instead of becoming hypertrophied as commonly happens in a young and healthy person. 3. Again, atony may be due to cystitis, owing to the inflammation having spread to the muscular coat, which then undergoes fibroid or fatty changes.

Symptoms.—The patient complains of inability to hold his urine, or that it constantly dribbles away, or that he has to pass it very frequently. The involuntary flow occurs at first during sleep; fterwards on any exertion causing contraction of the abdominal nuscles. These symptoms, although often improperly spoken of s incontinence, are really those of retention, the bladder being fully distended, but unable to empty itself, and the excess flowing involuntarily away.

The *treatment* consists in passing a catheter at regular intervals and as often as may be necessary to completely empty the bladder; whilst, in the meantime, the condition leading to the atony must be treated by appropriate means. Thus, if the result of overdistension, strychnine and galvanism or ergot (ext. ergot. liq. ʒjs. to ʒj.) may be tried; if the result of gradual distension from enlarged prostate or stricture, these conditions must be treated in the way mentioned under their respective heads. In both paralysis and atony, cystitis, dilatation of the ureters, pyelitis, and disorganization of the kidney rapidly ensue if the cause of the bladder trouble cannot be relieved.

True paralysis of the bladder is nearly always the result of disease or injury of the brain or spinal cord, and is not met with except in general paralysis. The bladder being paralysed cannot empty itself, and becomes distended as in atony; and when it can hold no more, the excess overflows through the sphincter, which is also paralysed. *Reflex paralysis*, however, often occurs after an injury or surgical operation, especially that for hæmorrhoids. The local *treatment* consists in the regular passage of a catheter two or three times daily.

Tubercle of the bladder is rare, and is nearly always secondary to tubercle in other parts of the genito-urinary tract. There is pain, hæmorrhage, and other signs of chronic cystitis; but the diagnosis will depend on the exclusion of other diseases such as stone, tumours, &c., and the presence of tubercle in other organs, and of the tubercle bacillus in the urine. *Treatment.*—The general constitutional remedies for tubercle should be employed; together with such local remedies as are indicated for cystitis, and for the assuaging of the pain. These failing to relieve, suprapubic cystotomy may be done and the bladder washed out, and such caseous masses of tubercle as permit of it scraped away.

Vesico-intestinal fistula may be known by the occasional passage of fæcal matter and gas by the urethra, and is usually a source of great discomfort. It commonly depends on inflammatory or other form of ulceration of the intestine involving the bladder. *Treatment.*—When the fistula is thought to be low down the intestine the abdomen may be explored, and the colon above the fistula united to the abdominal wall and then opened.

The tumours that may be met with in the bladder are:—1. *The fibrous.* 2. *The myxomatous.* 3. *The villous or papillomatous.* 4. *The malignant.* The *fibrous* and *myxomatous* spring from the submucous coat, and protruding the mucous membrane in front of them assume a polypoid or warty shape (Fig. 357). They are very rare. *The villous or papillomatous* spring from the mucous membrane and appear as soft, flocculent growths resembling the villi of the chorion (Fig. 358). They are the most common of the innocent growths. *The malignant* either spring from the mucous or the submucous coat, and may form a large mass often nearly filling the

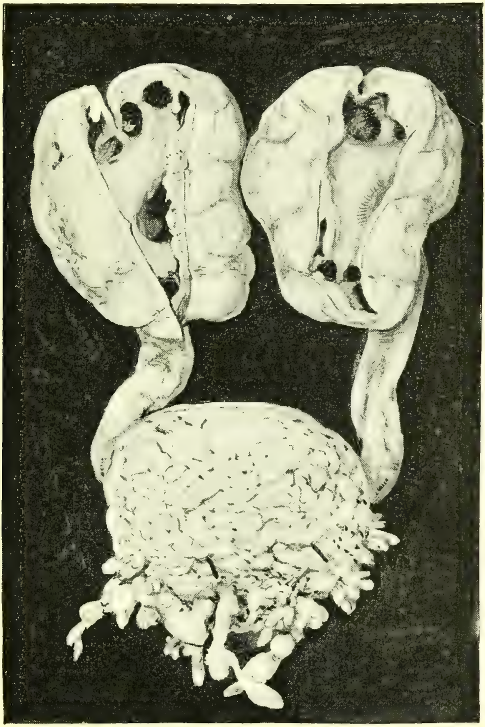

Fig. 357.—Myxomatous polypi of the bladder from a child two years old. The bladder has been everted and is almost completely occupied by partly sessile, partly stalked, transparent myxomatous polypi. Bristles are passed into the ureters which are dilated and thickened. The kidneys are hydronephrotic. (St. Bartholomew's Hospital Museum, No. 2147*a*¹.)

bladder, or assume a villous appearance, or merely infiltrate the walls. They have either a carcinomatous or sarcomatous structure.

The *symptoms* common to all are those of a foreign body in the bladder, with hæmaturia and absence on sounding of stone. In the *fibrous and myxomatous* there are signs of obstruction to the urinary outlet, pain and increased micturition, but little or no hæmaturia, and the tumour may sometimes be felt with the sound.

In the *villous* (Fig. 358) there is usually more or less continuous hæmorrhage without any other cause being discoverable to account for it; there is seldom any marked obstruction to the urinary outflow; and shreds of the growth may come away spontaneously or in the eye of the catheter. In the *malignant* there are usually sudden attacks of severe hæmorrhage from time to time; and a growth may be felt by the sound, or by the finger in the rectum, or by palpation above the pubes. There are commonly, moreover, other signs of malignancy, as rapid growth of the tumour, cachexia, &c. Tumours of the bladder, however, especially the villous, are often difficult to diagnose; some aid, it is true, may be gained by the electric cystoscope, but a diagnosis cannot always be made without a digital exploration of the bladder, which should be undertaken where symptoms such as the above are persistent unless they point to a malignant growth. In using the cystoscope a measured quantity of fluid should be left in the bladder, which should be previously irrigated, if the urine contains blood or pus, till the fluid returns clear.

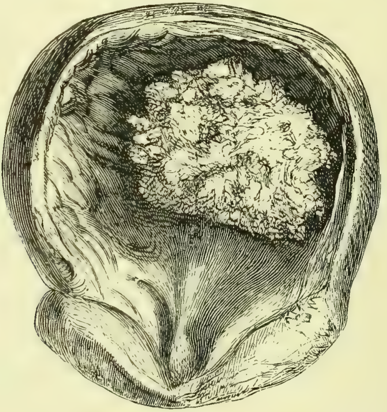

FIG. 358.—Villous tumour of the bladder. (St. Bartholomew's Hospital Museum.)

Treatment.—The removal of the tumour, except it is malignant, should generally be attempted. In the female the urethra may be dilated for this purpose. In the male the incision into the bladder should be made above the pubes, and the site of the tumour lighted up by passing a large glass vaginal speculum into the bladder so that the tumour may lie included in its lumen. If more light is required a small electric lamp on a slender handle can be passed down the speculum. The growth may be then removed by the cold wire or galvano-cautery loop, or by forceps, or be burned off with the actual or galvano-cautery. If a villous tumour is simply torn off by forceps, severe hæmorrhage, which I have known to prove uncontrollable and end fatally, may ensue. Tumours infiltrating the anterior wall, if not too large, may be removed by raising the peritoneum, excising the growth with the infiltrated wall, and uniting the edges of the wound with sutures. When removal is contra-indicated, relief, where there is obstruction to the urinary outlet, may be obtained by suprapubic puncture; hæmorrhage should be restrained by astringents; and pain assuaged by opium.

STONE IN THE BLADDER may occur at any age, but is said to be most frequent between the ages of fifty and seventy; next, between the ages of two and six; whilst, between the ages of twenty-six and thirty-six it is rare. It may occur in both males and females, but is decidedly more common in the former. It is most frequently met with in the children of the poor and in old men of the upper classes, with more or less enlargement of the prostate and of gouty habit.

The *causes* are not altogether known, but (1) residence in certain districts or countries, as around Norwich and in the North-West Provinces of India, and (2) derangements of digestion leading to an excess of urates in the urine as from (*a*) improper feeding or poor living, as evidenced by the frequency of stone in the children of the poor, (*b*) the abuse of alcohol especially in the form of malt liquor, (*c*) excess of nitrogenous food, (*d*) want of sufficient exercise, &c., are regarded as predisposing causes. Retention of urine from prostatic enlargement, the small size of the urinary passages in male children, and the presence of a foreign body in the bladder are exciting causes. The causes of oxaluria and of cystinuria and the consequent formation of the oxalate of lime and the cystine calculus are quite unknown. In a few cases a nucleus has been formed for a calculus by a piece of necrosed bone which has reached the bladder from a fractured pelvis or carious spine.

Varieties.—The three most common varieties of calculi met with in the bladder are the uric acid, the oxalate of lime, and the phosphatic. They may occur almost pure or they may be mixed. According to Sir Henry Thompson the uric acid and urates form one half of the number met with; the phosphatic one quarter; the mixed one quarter; and the oxalates only three per cent. of the whole. The uric acid and the oxalate of lime are generally formed on a nucleus of one of these substances which has descended from the kidney. The phosphatic is formed in the bladder itself, either on a nucleus of phosphates deposited on some inspissated mucus or a foreign body, or on one of the other forms of stone which has descended from the kidney and which sooner or later acts as a foreign body. The oxalate of lime is the most slow of formation and is consequently the hardest and most compact. The phosphatic forms very rapidly, is soft and friable, and often of very large size. Sometimes alternate layers of uric acid, oxalate of lime, and phosphates occur in the same stone (*alternating calculus*), a condition probably due to varying states of the patient's health, effects of medicines, bladder irritation, &c. A description of the various forms of calculi is given in the section on *Urinary Calculi* (p. 700).

The *character* of the stone may to some extent be guessed at by the state of the urine. Thus if the urine is acid it will probably be either oxalate of lime or uric acid; if alkaline, phosphatic. Calculi vary in size from that of a hemp-seed to a large mass weighing many ounces; but large stones, at the present day, in consequence of improved diagnosis, and the diminished dread a patient has of an operation, are the exception. They generally occur singly, but there may be two, or even more; they are then usually facetted from rubbing against one another.

Spontaneous fracture sometimes happens, and has been attributed: 1, to the swelling or chemical alteration of the cementing material with which the particles of the calculus are held together; 2, to two stones coming into collision; 3, to the compression of the calculi by the hypertrophied muscular coat of the bladder.

The calculus may be variously situated in the bladder. It is usually free just behind the prostate, but it may be in the upper fundus behind the pubes, or in one of the sacculi so often found in long-standing disease of the bladder (encysted). Calculous matter may sometimes be deposited upon growths in the bladder or upon the ulcerated mucous membrane.

The *terminations of stone*.—If neglected, cystitis is set up, and inflammation may spread up the ureters to the kidneys, leading to the changes described under *Surgical Diseases of the Kidneys.* In consequence, moreover, of the obstruction of the urinary outlet, the bladder may become hypertrophied, and the ureters and kidneys dilated in the way described under *stricture*.

Symptoms.—The three chief symptoms are—1. Pain, generally referred to the end of the penis, and worse after micturition on account of the stone then falling on the sensitive trigone and the walls of the bladder contracting upon it. 2. Frequent micturition; and, 3. A little blood in the urine. These symptoms are increased on exercise, especially riding, and after the jolting of a railway journey, &c., and are least marked at night when the patient is at rest. Other symptoms that may be present are the passage of gravel; sudden stoppage of the stream during micturition; the presence of muco-pus in the urine owing to cystitis; piles in adults and prolapse of the rectum in children, due to straining; and elongation of the prepuce in boys caused by the constant handling to relieve pain after micturition. Stone in the bladder may be simulated by cystitis, an enlarged prostate, a long or adherent prepuce, a narrow meatus, a growth in the bladder, calculous or other disease of the kidney, a peculiar choreic condition of the bladder (the stammering bladder of Sir James Paget), tubercle of the bladder, and ascarides in the rectum. An accurate diagnosis, however, can only be made by sounding the bladder; though in boys the stone may be felt by the finger in the rectum whilst pressure is made with the other hand above the pubes.

Sounding the bladder.—The ordinary sound (Fig. 359) is a solid steel instrument with a short bulbous beak. Thompson's sound is hollow to allow some of the urine to be drawn off if desired, and has a handle like that of his lithotrite, to facilitate the necessary movements in the bladder. Having warmed and oiled the sound, pass it like a catheter, letting it glide into the bladder by its own weight without using any force. When the sound is in, gently push it onwards to examine the posterior part of the bladder. Then turn the beak alternately to either side; and depress the handle between the patient's thighs to search the upper fundus. Then turn the beak downwards to examine the base or lower fundus. If the stone is not detected, let out a little of the urine, or change the patient's position, or raise his pelvis and try again. The stone may not be felt, because it is of so small size, or has become encysted, or entangled in a fold of mucous membrane. A guarded opinion, therefore, should be given, and a further examination made another day. A stone may be known to be present by the peculiar ring which is both felt and heard on striking it. This ring is quite unlike the sensation given to the sound by its coming into contact with phosphatic deposits on a roughened or fasciculated bladder, or growth, or with one of the pelvic bones. Having discovered a stone, the next care should be to determine approximately—1, its probable size and composition; 2, whether it is free or encysted; 3, whether there is one stone or more; and, 4, the condition of the bladder and urethra. 1. The *size of the stone* can be roughly estimated by the amount of resistance offered on pushing it before the sound or by passing the sound over it, and by feeling it through the rectum with the other hand pressing on the hypogastrium. Its exact size can only be ascertained by seizing it with the lithotrite, the distance the blades are then apart being indicated by the scale on the handle. The *composition of the stone* may be approximately

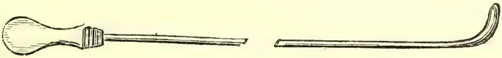

FIG. 359.—Ordinary sound.

arrived at by (*a*) the character of the ring on striking it—the clearer the ring the harder the stone, (*b*) the condition of the surface, which is rough in the oxalate of lime and smooth in the phosphatic, (*c*) the reaction of the urine, and (*d*), the general health of the patient. 2. A *stone, when encysted*, is always felt at the same spot in the bladder, and when seized with the lithotrite cannot be moved. The sound cannot be passed all round it. There is no blood present, and the symptoms are usually less severe, and are not increased by exercise. 3. The *presence of a second stone* can only be determined with certainty by seizing one stone with the lithotrite, and then striking the other.

Treatment.—The stone may be removed by crushing (*lithotrity*), or cutting (*lithotomy*). In adults, lithotrity, with but few exceptions, should be the rule. In children, up to twelve or fourteen years of age, lithotomy has hitherto been the recognised operation; but I believe that when the brilliant results obtained by Surgeon-Major Keegan and others come to be better known, that even in very young children, lithotrity, as in adults, will also be the rule, lithotomy the exception. I have myself crushed six or seven stones in young male children, some as young as three years, and successful cases are now being frequently reported. In adults, lithotomy should be practised in place of lithotrity, 1, when the stone is very large and hard; 2, when the urethra is the seat of intractable stricture; 3, when the stone is encysted; and, 4, when the bladder is sacculated. A large stone, if soft, should be crushed; and a hard stone, if not too large, is no bar to the operation. Surgeon-Major Keegan has crushed a uric acid stone, the fragments of which weighed two ounces and three quarters, and an oxalate of lime which weighed one ounce and three drachms. And in a boy, aged thirteen, I crushed and successfully removed a very hard stone weighing only a few grains less than an ounce. Hard stones, however, weighing above an ounce, and especially in boys, had better be removed by cutting, unless the surgeon is experienced in lithotrity. Cystitis and kidney disease render the prognosis of both operations unfavourable; but in these affections it does not appear that crushing, with complete removal of the fragments, is attended with more risk than is lithotomy. A large prostate renders lithotrity difficult no doubt, but does not, as a rule, contra-indicate it. Stricture of the urethra is only an impediment to lithotrity when the stricture cannot be dilated. The conditions, however, most favourable for success in lithotrity are, as well expressed by Sir Henry Thompson, "a capacious urethra, a bladder capable of retaining three or four ounces of urine, absence of ordinary signs of renal disease, and fair general health."

LITHOTRITY, LITHOLAPAXY, OR BIGELOW'S OPERATION consists in crushing the stone in the bladder, and removing the *whole* of the fragments through a large evacuating catheter. Formerly, it was taught that the presence of the lithotrite in the bladder for more than a few minutes at a time was productive of great irritation, and it was consequently advised that the crushing of the stone should be extended over several sittings of only a few minutes each, and the fragments allowed to be passed by the natural efforts of the patient. To the late Professor Bigelow is undoubtedly due the credit of having enunciated the principle that the bladder is not so intolerant of instruments as was formerly supposed, and that it was to the presence of the fragments, rather than to the lithotrite, that the irritation, cystitis, &c., so common after the old method, should be ascribed.

The operation.—The patient, having been prepared for the operation by careful attention to the general health, rest, and such local means for allaying chronic cystitis as were pointed out under that head, should be placed under an anæsthetic, with the pelvis raised a few inches, the thighs slightly apart, the knees supported on a pillow, and the body and legs well wrapped up in blankets to avoid a chill. The rectum should be emptied by a purge the day before, and by an enema on the morning of the operation. A few ounces of urine in the bladder is desirable. If necessary, incise the meatus (a stricture, if present, should have previously been dilated), warm and oil the lithotrite (Fig. 360), and pass it with all gentleness, letting it glide by its own weight through the spongy and membraneous portion of the urethra, and do not depress the handle till the blades have reached the prostrate. Then bring the shaft to an angle of 35 degrees with the horizon, and it will glide through the prostatic urethra, over the trigone of the bladder, and may possibly be felt to graze the stone. The blades now rest in the lower part of the bladder and point upwards (Fig. 361). Hold the handle tightly with the left hand, and, without moving the instrument, open the male blade by drawing out the wheel-shaped end with the right hand. Pause a few seconds to allow the currents set up in the urine by this movement to subside. Then gently press in the male blade, and the stone will probably be caught. If so, continue the pressure on the wheel to retain the stone between the blades, whilst the button is moved by the thumb to convert the sliding into the screw movement. Rotate the instrument slightly to make sure that the mucous membrane is not caught by the blades; slightly

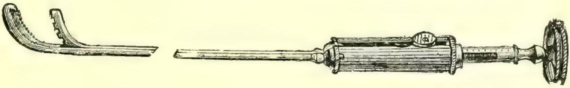

FIG. 360.—Thompson's lithotrite.

depress the handle to raise the blades from the wall of the bladder, and screw home. The stone will probably be felt to crack and break into fragments. If the stone cannot be seized in this way, systematically explore the bladder thus:—Open the blades and rotate 45 degrees; pause and close. Do this first to the right, then to the left. Then raise the blades slightly by depressing the handle; rotate alternately to right and left 90 degrees; further raise the blades and rotate 135 degrees. Finally, reverse the blades by rotating half a circle. In this way the stone will probably be found. In these manœuvres the blades should be opened before rotating them in order that the stone may not be displaced by the male blade, and, after rotating, a pause should be made before closing them to allow the currents to subside. Having crushed the stone and larger fragments, withdraw the lithotrite, first screwing tight home to ensure complete closure of the blades in order to prevent laceration of the urethra. Next introduce a large evacuating catheter (No. 16, or larger); let all the urine escape and inject two or three ounces of warm water. Attach the aspirator, previously filled with water at a temperature of 98 degrees, and compress the india-rubber bulb, driving some of the water into the bladder. Let the bulb expand and the outward current will bring away some of the fragments and *débris* which will fall into the receiver and be prevented from running into the bladder by the trap (see Fig. 362) on again compressing the bulb. Continue compressing and relaxing till fragments cease to come away. Then if any are felt by the evacuating catheter, re-introduce the lithotrite, or a

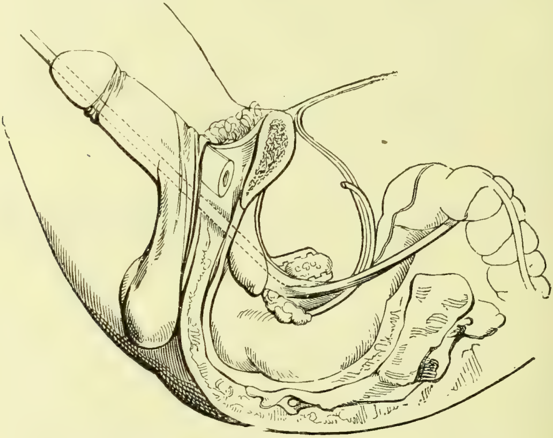

Fig. 361.—Lithotrite *in situ*. (Liston's Surgery.)

smaller one, and crush again and aspirate as before, repeating this *till all the fragments are removed.* The operation frequently lasts for an hour to an hour and a half or longer.

After-treatment.—Opium, if no serious kidney disease is present, may be given; and hot hip-baths if there is much pain. If there is retention the catheter should be used at regular times, or tied in if its passage causes much irritation and pain. Complete rest in bed for a few days or longer should be enjoined. If cystitis follows the operation, Sir Henry Thompson strongly recommends a weak injection of silver nitrate (gr. i. to f℥i). As a rule, however, I have found no after-treatment required, even in young boys, Indeed in several cases the child has been up and playing about the ward the day after the operation.

After-complications.—1, Rigors and fever, 2, retention of urine, 3, acute cystitis, 4, prostatitis and abscess, and 5, orchitis and epididymitis, occasionally occur. More rarely, 6, hæmorrhage, 7, suppression of urine, and 8, phlebitis of the prostatic plexus of veins, followed by pyæmia. The impaction of a fragment of the calculus in the urethra (formerly common when the fragments were left in the bladder), cannot occur if the bladder has been thoroughly evacuated.

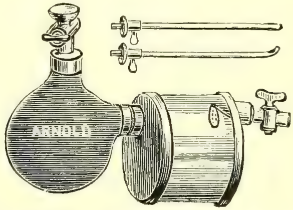

FIG. 362.—Thompson's improved evacuator and trap.

Causes of death.—Death may occur from 1. Acute nephritis; 2. Pyelitis; 3. Cystitis; 4. Perforation or rupture of the bladder; 5. Peritonitis; 6. Sapræmia or pyæmia; or 7. Exhaustion. But a fatal termination is rare except when there is some chronic kidney disease.

LITHOTOMY, or cutting for the stone, may be performed through *the perineum* or above *the pubes.* Perineal lithotomy may be done in many ways; the lateral, as usually performed, and the median will only be described.

LATERAL LITHOTOMY.—The patient should be prepared by rest in bed for a few days, and the rectum cleared by a mild purgative the day before, and by an enema on the morning of the operation. The bladder should contain five or six ounces of urine, or if the patient is unable to retain so much, an equal quantity of warm water should be injected. Anæsthetize the patient, introduce a full-sized staff with a groove on the left side into the bladder, and try to strike the stone. If the stone is not felt, withdraw the staff and pass a sound. If still unsuccessful, send the patient back to bed as the stone may have been passed per urethram or become encysted. If felt by the sound, re-introduce the staff, but do *not* operate until the staff itself strikes the stone, that you may be sure that the staff has passed into the bladder, and not into a false passage. It is usual to ask an assistant to strike the stone also. Next, place the patient in the lithotomy position, *i.e.*, with the soles of the feet secured in the palms of the hands by the lithotomy shackles, and bring his nates well over the end of the table. Entrust the staff to an assistant, who should hold it perpendicularly with its concavity hooked well up under the pubes and exactly in the middle line. Seat yourself in front of the patient, and having introduced the left forefinger into the rectum to make sure that it is empty, and to induce it to contract, enter the knife (Fig. 363), which should be held horizontally, a little to the left of the middle line, and about an inch and a quarter in front of the verge of the anus, and carry the incision downwards and to the left to a point one-third nearer to the tuberosity of the ischium than to the margin of the anus. Pass the left forefinger into the upper angle of the wound and feel for the staff; divide with the knife the superimposed tissues; insert the finger-nail into the groove in the staff, the back of the finger being to the patient's left; and, guided by the nail, press the point of the knife into the groove just in front of the membraneous portion

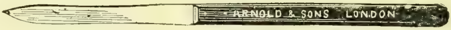

FIG. 363.—Lithotomy knife.

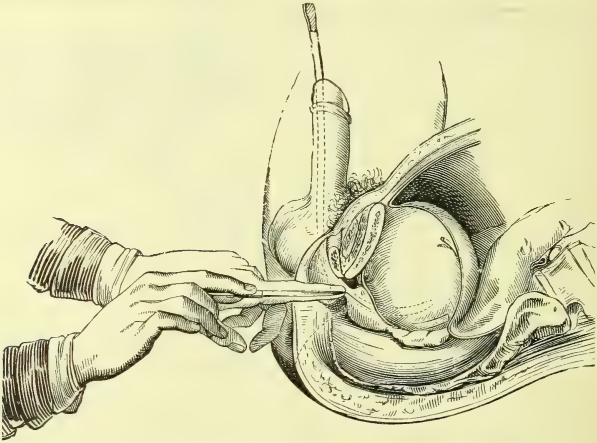

FIG. 364.—Parts cut in lithotomy. (Fergusson's Surgery.)

of the urethra (Fig. 364). Now run the knife, with the point pressed firmly in the groove, onwards into the bladder, keeping its blade well lateralized, *i.e.*, directed downwards and to the left. Take care not to depress the handle too much for fear of cutting the prostate too widely, nor to hold it too horizontal lest the point slip out of the groove and penetrate the tissues between the bladder and the rectum. Having entered the bladder, slightly enlarge the wound in the prostate in withdrawing the knife, and pass the left forefinger, which is in the wound, onwards along the staff into the bladder. If the stone is felt by the finger ask the assistant to withdraw the staff. Take the forceps in the right hand, pass them along the left forefinger towards the bladder, and, on withdrawing the finger, open the blades, and the stone will probably be driven by the gush of urine between them. Having assured yourself that the stone is grasped by the forceps in its smallest diameter, extract it by making traction downwards and backwards in the axis of the pelvic outlet. Re-introduce the finger into the bladder to ascertain whether there may not be another stone, and if in doubt use the searcher. Inject two or three syringefuls of cold water into the bladder; dust the wound with iodoform; apply no dressings; tie the legs together if the patient is a child, and send him back to bed as quickly as possible. If there is hæmorrhage, tie any bleeding point which is seen, or if the blood comes from the deep part of the wound, introduce the petticoated tube (Fig. 365), assuring yourself that the end is in the bladder by injecting water and passing a probe through it. Then plug firmly round with strips of lint between the petticoat and the tube.

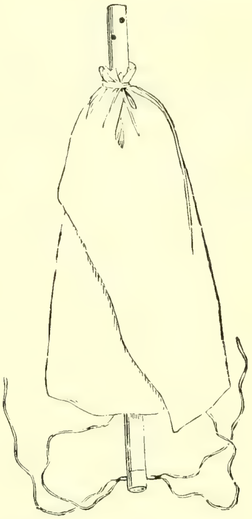
Fig. 365.—Petticoated tube.

At Guy's Hospital lateral lithotomy is performed on a straight staff, by the operation know as Key's. A good description of the method will be found in Bryant's Surgery.

The *structures divided in the operation* are:—1, the skin; 2, the superficial and deep fascia; 3, a few branches of the external hæmorrhoidal vessels and nerves; 4, the transversus perinei muscle, vessels and nerve; 5, a few fibres of the accelerator urinæ and levator ani muscles; 6, the compressor urethræ muscle; 7, the membraneous portion of the urethra; and 8, the prostate.

The dangers of the operation are:—A. *Before the point of the knife* *has entered the groove in the staff*—1, wounding the rectum, either from cutting too perpendicularly, or from not having had it cleared out by an enema; 2, wounding the artery of the bulb in consequence of beginning the incision too high, or directing the point of the knife subsequently too much upwards; and 3, missing the groove in the staff. B. *On entering the bladder*—1, letting the point of the knife slip out of the groove in the staff and enter the cellular tissue between the bladder and rectum; 2, cutting the pudic artery from holding the knife too much lateralized; 3, sending the point of the knife through the posterior wall of the bladder; 4, cutting the prostate too widely, and dividing its capsule, whereby the urine may be extravasated into the cellular tissue of the pelvis; 5, wounding the prostatic plexus of veins; 6, tearing the urethra across, and so pushing the bladder off the end of the staff, whilst trying to pass the finger into the bladder (this accident is due to not making the opening into the urethra large enough, and is most common in children in whom the tissues are readily lacerable); 7, making too small an incision in the prostate so that the parts are bruised or torn in removing the stone, and inflammation is set up; 8, seizing the walls of the bladder by the forceps. *These dangers may be best avoided by observing the following rules*—1, feel the stone with the *staff* before you begin the operation; 2, see that the rectum is empty, and make it contract by introducing the finger; 3, make the external incision free; 4, feel *both* edges of the groove in the staff with the finger, and place the point of the knife *between* them; 5, keep the point of the knife well pressed into the groove of the staff; 6, take care that the finger is pushed into the bladder in *contact* with the naked staff; 7, do not remove the staff till the finger touches the stone.

The difficulties of the operation.—In adults the chief difficulty is to extract the stone; in children to get into the bladder. A. *The difficulty in entering the bladder* depends chiefly on—1, not making the opening into the urethra free enough, and so pushing the finger between the bladder and the rectum; 2, a deep perineum so that the finger cannot reach the bladder; in such case a blunt gorget must be substituted for the finger. B. *The difficulties in extracting the stone* are—1, the stone may be too large; 2, it may get behind the prostate; 3, it may be lodged in a pouch in the upper fundus; 4, it may be encysted; 5, it may break or crumble up; 6, it may be so small that it slips from between the blades of the forceps; 7, there may be an enlargement of, or tumour in, the prostate, whereby the urethra is greatly lengthened; 8, there may be some rickety or other deformity of the pelvic bones. When the stone is behind the prostate, curved forceps, with the blades turned down, must be used; when the stone is above the pubes, the blades must be turned upwards, the handle depressed, and the stone pressed down by the hand above the pubes. When too small to be seized, the scoop must be substituted for the forceps. If the stone breaks, the fragments must be removed by aid of the scoop and syringe. If encysted, it may be scratched out with the finger-nail, or freed with a probe-pointed bistoury. If too large to be extracted, the wound should first be slightly enlarged; or, this being insufficient, three expedients remain—1, to make an incision in the opposite side of the prostate; 2, to crush the stone; 3, to do the suprapubic operation. The first of these is probably the best. To overcome the difficulty of an enlarged prostate, the blunt gorget must be used and the forceps slid along it. A fibrous tumour in the prostate may be previously shelled out. Where the pelvic outlet is too small to allow of extraction, suprapubic lithotomy must be done.

Causes of death after lithotomy.—1. Diffuse septic inflammation of the cellular tissue of the pelvis due either to infiltration of the urine from too free cutting, or to bruising of the parts in extracting a large stone through a small incision; 2, peritonitis due to the spread of the inflammation to the peritoneum, or to a wound of the back of the bladder; 3, shock from too prolonged an operation; 4, exhaustion from primary or secondary hæmorrhage; 5, blood-poisoning, due to the absorption of the products of putrefaction (sapræmia), or to septic phlebitis of the prostatic plexus of veins and pyæmia; 6, cystitis; and 7, suppression of urine. The state of the kidneys is of the most serious import. Where these are healthy, as in children, lateral lithotomy is one of the most successful operations in surgery; but in adults, in whom grave kidney mischief often exists, it is liable to be followed by one or more of the above complications, especially diffuse pelvic inflammation. Thus, in boys, when death occurs it is generally the result of some one of the accidents liable to occur during the operation; in adults the cause is usually dependent primarily on kidney mischief.

The *after-treatment* is very simple, and consists in little more than keeping the patient clean, and in regulating the secretions and diet. Adults may be placed on a mattress, with a hole opposite the perineum, for the purpose of letting the urine drain through. During the first few hours it is essential to see that the wound is free. Should the urine not escape from it, it is probably plugged with a clot of blood; the finger must then be passed into the wound, or if a tube has been introduced, this must be cleared by a probe or feather, or by syringing. From the third to the fifth day, in consequence of inflammatory swelling, more or less of the urine is passed by the urethra, but as this swelling subsides, the greater part may again pass by the wound; more, however, is gradually passed by the natural way and less by the wound, as the latter slowly heals. Should secondary hæmorrhage occur, the wound must be plugged; or if this fails to arrest it, perchloride of iron or the actual cautery must be used. For the treatment of the other complications see Cellulitis, Peritonitis, &c.

MEDIAN LITHOTOMY.—Pass a staff, grooved on its convexity, into the bladder, and, with the left forefinger in the rectum, feel for the apex of the prostate. Make an incision with a straight bistoury, with its back towards the rectum, in the median line of the perineum, beginning about half an inch in front of the anus. Insert the point of the knife into the groove of the staff just in front of the prostate, notching the apex, and cut a little upwards, opening the membraneous portion of the urethra. Withdraw the knife, slightly enlarging the external incision upwards if necessary, and pass a long bulbous probe along the groove of the staff into the bladder. Withdraw the staff, and gently work the forefinger into the bladder along the probe, thus dilating the prostate. Extract the stone in the usual way. The operation is suitable—1. For small stones or foreign bodies; 2. When it is important that there should be little loss of blood; 3. For the removal of small growths; and 4. For exploring the bladder in doubtful cases of disease. All the cutting is done entirely in the median line where no vessels exist; the deeper parts of the wound are merely dilated, not cut. Median lithotomy may be combined with lithotrity through the wound (*perineal lithotrity*), a straight lithotrite being then used.

SUPRAPUBIC LITHOTOMY consists in opening the bladder between the pubes and the peritoneal fold. It is the method that should be employed for the removal of very large stones, and for certain forms of tumour in the bladder. First, pass a Petersen's india-rubber bag into the rectum, and dilate it with water, and distend the bladder with air or a weak antiseptic solution; it will then rise well into the abdomen and appear as a prominent tumour, dull to percussion above the pubes. Make an incision in the middle line immediately above the symphysis (Fig. 305, b), and having divided the tissues forming the linea alba, expose the wall of the bladder by gently separating the fatty tissue that lies in front of it with the finger or director, avoiding the peritoneal fold, and, if possible, the large veins which ramify in this situation. The bladder having been fixed by inserting a sharp hook into its walls, make an incision into it; introduce the finger to ascertain the size of the stone; enlarge the wound, if necessary, by cutting towards the pubes, and extract the stone with the finger and scoop, or with the forceps. The wound in the bladder may be left open, and the patient placed on his side to ensure an efficient drain and prevent the tissues being infiltrated with urine; or it may, if the bladder and urine are healthy, be closed by suture. Some tie in a full-sized catheter, but it is not necessary and is perhaps harmful.

CALCULUS IN THE FEMALE BLADDER is much less common than in the male, a fact in great part due to the shorter and more dilatable urethra in women, to the absence of a prostate and consequent exemption of the female from chronic retention and phosphatic deposits, and perhaps also to the more regular habits of women. The symptoms are similar to those in the male, but are sometimes apt to be accompanied by incontinence of urine. They may, at times, be simulated by vascular growths in the urethra, by uterine disease, and by hysteria.

Treatment.—1. When the stone is small, rapid dilatation of the urethra with the finger or with the three-bladed dilator or dressing forceps is the best method of extraction. 2. When of larger size (above three-quarters of an inch in children and one inch in adults), lithotrity with removal of the fragments at one sitting should be done. 3. When too large for removal by dilatation, and the bladder is too contracted to allow of crushing, the suprapubic operation is called for.

Slow dilatation, dilation with incision (*urethral lithotomy*), and incision through the vagina (*vaginal lithotomy*) are very liable to be followed by incontinence of urine, especially in children.

INCONTINENCE OF URINE OR ENURESIS.—Involuntary escape of urine from the bladder may occur under several conditions. Thus —1. The urine may dribble away as fast as it enters the bladder, in consequence of paralysis of the sphincter vesicæ and inability to close the urinary outlet (*true incontinence*). 2. The urine may be passed involuntarily during sleep without any organic change in the urinary apparatus being discoverable (*nocturnal or active incontinence*). 3. The urine may constantly flow away, in consequence of the bladder being over-distended and capable of holding no more (*retention with incontinence*, or *false incontinence*). This last condition, which usually depends on obstruction to the outflow, will be described under *Retention of Urine* (p. 746). The importance of recognizing that it is one of the nature of retention rather than of incontinence cannot be too strongly insisted upon. Whenever, therefore, a patient complains that he is unable to hold his water, or that it is continually dribbling away, an over-distended bladder should be suspected, the abdomen examined for such, and a catheter passed.

1. *True incontinence of urine* is very rare. *In males*, it may be due—(*a*), to a peculiar form of enlargement of the middle lobe of the prostate, whereby the urethra is rendered patent instead of being obstructed as is more commonly the case in enlarged prostate; (*b*), to a like patency of the urethra from the impaction of a calculus at the neck of the bladder or from a prostatic calculus; (*c*), to disease or injury of the spinal cord, implicating the lumbar enlargement, and inducing the bladder to become so contracted and thickened that it cannot hold any urine. *In females* it may be due —(*a*), to over-dilatation of the urethra, as in extracting a calculus

from the bladder; (*b*), to injury of the parts during parturition; and (*c*), to vesico-vaginal fistula. The *treatment* consists in removing the cause, or if this is impracticable, in rendering the patient's condition as comfortable as possible under the circumstances by a urinary convenience.

2. *Nocturnal or active incontinence* generally occurs in children, and must be distinguished from the involuntary passage of urine which is an occasional symptom of thread-worms, calculus, long prepuce, or growth in the bladder. In nocturnal incontinence proper, beyond that the child wets his bed, no sign of disease of any kind is discoverable. *Treatment.*—Presupposing that the absence of thread-worms, calculus, long prepuce, and growth in the bladder has been ascertained, the treatment should consist in tonics, cold baths, and the administration of belladonna in increasing doses till symptoms of belladonna poisoning appear. The child should lie on his side, not on his back, and be awakened at regular intervals to pass water. I have found the continuous galvanic current of service; one pole should be applied over the urinary centre in the lumbar region, the other to the perineum. In obstinate cases, Sir Henry Thompson advises the application of a solution of silver nitrate (grs. x to ℥j) to the neck of the bladder.

HÆMATURIA, or bloody urine, is generally a symptom of disease or injury of the urinary organs, but may also occur in certain constitutional conditions, as scurvy, purpura, malaria, the hæmorrhagic diathesis, and in some fevers. When blood is present in large quantities, the urine will be bright red or coffee or porter coloured; when in smaller quantities, of various shades of brown to which the term "smoky" is applied. Blood may be simulated by urates, indican, bile, or rhubarb or other colouring matter which may have been introduced by impostors. The dark greenish colour of the urine which is produced by the absorption of carbolic acid from a wound must not be mistaken for blood. Blood may be distinguished by blood-globules being seen under the microscope, by the spectroscope, or by the ozonic ether test. Add a few drops of tincture of guaiacum to the suspected urine, and then an excess of ozonic ether, shake the mixture and allow it to stand; it will assume a blue colour if blood is present. The same reaction occurs if the patient is taking potassium iodide. Albumen will be detected in the urine if blood is present in quantity.

Source of the blood.—The blood may come from—1, the kidney or ureter; 2, the bladder or prostate; or 3, the urethra. *When from the kidney or ureter* it may be due to (*a*) injury, (*b*) congestion or inflammation, (*c*) Bright's disease, (*d*) the administration of turpentine or the application of a cantharides blister, (*e*) the presence of a parasite, the Bilharzia hæmatobia, in the pelvis of the kidney in persons who have been in Africa, (*f*) the impaction or passage of a calculus, (*g*) tubercle, (*h*) the passing of a catheter up the urethra, or (*i*) malignant disease. *When from the bladder or prostate* it may be due to (*a*) injury, (*b*) calculus, (*c*) cystitis or prostatitis, (*d*) tubercle, or (*e*) villous or malignant growths. *When from the urethra* it may be due to (*a*) injury, (*b*) gonorrhœa or chancre, (*c*) erectile growths, (*d*) calculus, (*e*) rupture of corpus spongiosum in chordee or sexual intercourse.

Diagnosis.—Blood from the *urethra* comes before the urine, is frequently pure, and may continue flowing between the acts of micturition. From the *bladder or prostate*, it generally comes after the urine, or the urine contains more blood at the end than at the beginning of micturition; it is often clotted from remaining some time in the bladder, and the urine then is of a porter-like colour. From the *kidney* it comes with the urine, with which it is intimately mixed (*smoky urine*). The urine may then contain blood-casts of the renal tubes, or when it comes from the *ureter*, fibrinous casts of the ureter.

The *treatment* resolves itself into remedying where possible the cause (see *Diseases of Kidney*, *Bladder*, &c.). When clots have collected in the bladder, they may be washed out with a stream of warm water; but when they are decomposing, it may be necessary to open the bladder through the perineum and remove them.

DISEASES OF THE PROSTATE.

ACUTE PROSTATITIS.—*Causes.*—Generally gonorrhœa, or stricture of the urethra; less frequently cystitis, impacted calculus, and passage of instruments. Occasionally, in gouty subjects, it appears to occur idiopathically. *Symptoms.*—Micturition is frequent, and attended with pain, especially at the end of the act; there is throbbing and continuous pain in the perineum and neck of the bladder, and pain during defæcation. When examined by the finger in the rectum, the prostate is found hot, swollen, and painful, and the passage of a catheter causes great pain. The febrile disturbance which accompanies it is perhaps ushered in by rigors. *Terminations.*—Resolution, abscess, or chronic inflammation. *Treatment.*—Six or more leeches to the perineum; hot hip-baths; hot poultices to the perineum; and a purgative at the onset, followed by alkaline medicines. A catheter is only to be passed if there is retention of urine.

ABSCESS OF THE PROSTATE is generally preceded by acute inflammation; but chronic abscess may be produced by catheterism in chronic enlargement of the organ. Acute abscess may be suspected, when, in the course of acute prostatitis, rigors and retention of urine supervene. Fluctuation can at times be felt through the rectum, but the abscess is generally first discovered on passing a catheter for the relief of the retention of urine, when a quantity of pus escapes from the urethra. At times the abscess may burst into the rectum or perineum. *Treatment.*—Free incision in the middle line of the perineum to let out the pus. When the pus forms around the prostate instead of in its substance, a *periprostatic* abscess is said to have occurred. The cause, symptoms, and treatment are similar.

CHRONIC PROSTATITIS generally occurs as a sequel to the acute. The symptoms are similar but of much less intensity; and there is a glairy discharge with, sometimes, a drop or two of blood in it. The urine is cloudy and contains pus and prostatic casts. Nocturnal emissions are frequent. If the inflammation is not relieved, cystitis may follow, and the bodily and mental health become seriously impaired. *Treatment.*—Blisters to the perineum; gentle laxatives; tonics, especially iron; change of air or a sea voyage; sea-bathing; a generous diet; and the avoidance of stimulants, horse-exercise and sexual indulgence. The application of silver nitrate to the prostatic urethra is recommended by some surgeons when there are nocturnal emissions.

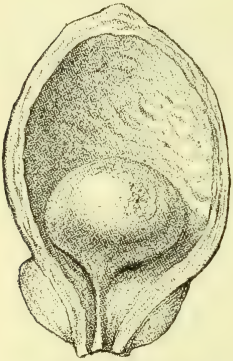

FIG. 366. — Enlargement of the middle lobe of the prostate. (St. Bartholomew's Hospital Museum.)

HYPERTROPHY, or chronic enlargement of the prostate, must be carefully distinguished from the enlargement due to inflammation. It seldom occurs under the age of fifty or sixty, and is a common, though not an invariable, disease of old men. It may be due to hypertrophy of all the tissues forming the prostate; or the glandular, muscular, or fibrous tissue only may be affected, then often forming distinct masses in the substance of the organ. The enlargement may involve the whole prostate, or may be confined to one or other of the lateral lobes or to the so-called middle lobe (Fig. 366). The *cause* is not known.

The *effects* of chronic enlargement of the prostate are very serious when the outflow of urine is impeded, similar changes occurring in the bladder, ureters, and kidneys as described under Stricture. The bladder behind the enlargement forms a pouch in which some urine may remain, after each act of micturition, unexpelled, and there, mixed with pus and mucus from the walls of the inflamed bladder, undergo decomposition, probably owing to the action of micro-organisms, the urea being converted into ammonium carbonate, and the phosphates in consequence precipitated. A stone may be thus formed or the bladder-walls encrusted.

Symptoms.—Increased frequency of micturition, especially at night; inability to propel the stream to the same distance as formerly, owing to the muscular fibres of the bladder being involved in the disease; and difficulty in commencing the act. Later, the bladder is imperfectly emptied: the retained urine becomes ammoniacal and alkaline in reaction; cystitis is set up, and retention of urine may finally occur, or a stone form.

Diagnosis.—These symptoms may depend upon causes other than enlarged prostate. It is only by a physical examination that the nature of the disease can be accurately made out. On introducing the finger into the rectum the prostate is felt enlarged, unless the middle lobe only is involved. On passing a catheter no obstruction is met with in the urethra, *i.e.*, the catheter passes six or seven inches without meeting with any, and then has to be well depressed before it can be made to enter the bladder. Or an ordinary catheter may not be long enough to enter the bladder, and a prostatic catheter may have to be used.

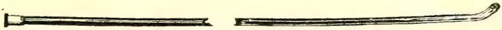

FIG. 367.—Coudé catheter.

Treatment.—In the early stages, so long as the bladder can be completely emptied by the patient's own efforts, the treatment should be directed to improving the general health. But as soon as it is found that obstruction is beginning to come on, Harrison's olive-shaped bougie may be passed daily so as to exert pressure on the prostate, and dilate the canal. If it is found, after urine has been passed, that the bladder still retains some ounces, then catheterism must be commenced. A soft catheter, or when the middle lobe is enlarged, a coudé or bi-coudé (Figs. 367, 368), should be used at regular intervals, and any cystitis which may exist should be treated as already described. As the disease advances the passage of the catheter may cause a very irritable condition of the bladder. Under such circumstances it becomes a question whether the bladder should be tapped above the pubes, and a cannula kept permanently in; or whether an incision in the middle line of the perineum should be made to drain the bladder. I prefer the latter method. When retention occurs, and it cannot be relieved by a catheter, the bladder must be tapped above the pubes. Recently the obstruction has been overcome by punching out a

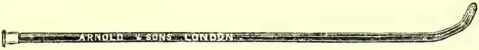
ARNOLD & SONS. LONDON.

FIG. 368.—Bi-coudé catheter.

piece of the prostate with an instrument invented for the purpose, by boring a new channel with the galvano-cautery, and by opening the bladder above the pubes and removing with the knife or cautery the obstructing portion of the middle lobe (*prostatectomy*). The removal of the obstructing middle lobe holds out the best prospect of success. Castration or orchectomy is recommended as likely to cause shrinking of the prostate, in the same way as the removal of the ovaries leads to atrophy of fibroids of the uterus. The operation has been followed by mental derangement, and should not be done for patients under the age of seventy. Care should be taken to be quite sure the obstruction is not due to a stone in the prostate. In place of removing one or both testes the vas may be tied and divided where it leaves the external ring. This is a less serious operation than excising the testes.

TUBERCLE OF THE PROSTATE may occur in the course of general tuberculosis, or in connection with tuberculous disease of the genito-urinary tract. It gives rise to inflammation, and sometimes suppuration, in or about the organ; but its diagnosis will depend on the presence of tubercle in other parts, as the testicle, bladder, vesiculæ seminales, &c., and of the tubercle bacillus in the urine. The local scraping away of caseous material may give some temporary relief.

MALIGNANT DISEASE.—Carcinoma in the old, and sarcoma in the young, may occur in the prostate, but both are rare. Pain, increased frequency in micturition, with passage of blood, often pure, at the end of the act; the presence in the urine of shreds of the growth; the detection in the rectum of a swelling of the prostate of unequal consistency and of rapid growth; enlargement of the lumbar and often also of the inguinal glands; and wasting and cachexia, are the symptoms by which it may be known. The *treatment* can only be palliative; *i.e.*, morphia to subdue pain, astringents to check hæmorrhage, and catheterism or suprapubic puncture to relieve retention.

PROSTATIC CALCULI are often found in abundance in the prostate of old men in the form of small, brown, seed-like bodies. They are composed of phosphates, with a little carbonate of lime and a large proportion of animal matter, and are believed to be formed by the inspissation of the prostatic secretion, and the subsequent deposit upon it of the earthy salts. Usually they give rise to no *symptoms;* but occasionally one or more encroach upon the urethra, and may attain such a size as to project into the bladder, then causing painful and frequent micturition, involuntary erections and escape of semen, or perhaps retention or incontinence of urine. A grating sensation, but no true ring, may be elicited on the passage of a sound. At other times the calculi may escape into the bladder and there, collecting in considerable numbers, give rise to symptoms of stone. Moreover, one or more may be periodically passed by the urethra. *Treatment.*—Unless the symptoms are severe, the calculi are better left alone; but should they attain a large size, or give rise to retention, &c., they should be removed through a median incision in the perineum. Extraction by the urethral forceps is not likely to succeed; but there is no harm in trying, if all gentleness is used. Where they have collected in the bladder they may be washed out by Bigelow's evacuator.

DISEASES OF THE URETHRA.

SIMPLE URETHRITIS, or inflammation of the urethra of a non-specific character, may be due to injury, catheterism, gout, the irritation of worms, the abuse of alcohol, or contact with leucorrhœal discharges. *Signs.*—Simple inflammation of the urethra is attended by a catarrhal, and at times by a muco-purulent discharge, and except in the mildest forms, it cannot always, without taking into account the history of the case, be distinguished from gonorrhœa. Like the latter affection it may, though much more rarely, be complicated by cystitis, prostatitis, epididymitis, nephritis, synovitis, and ophthalmia. The *treatment* is similar to that for gonorrhœa.

GONORRHŒA is an acute, infective, and specific inflammation, attended with a muco-purulent discharge. In the male it is most common in the urethra, in the female in the vagina and about the vulva; but it may attack any mucous membrane exposed to contagion.

Cause.—In the male it is nearly always due to direct contagion, and in the female it is also commonly contracted in this way; but in the female it may possibly be developed *de novo*, *i.e.*, evolved from a non-pathogenic organism through want of cleanliness and the decomposition of retained and foul discharges, but this is extremely doubtful.

Pathology.—Gonorrhœa is now regarded as a specific and infective inflammation, in that it has a distinct incubative period, is highly contagious, extends along the mucous tracts it attacks, and may secondarily affect the fibrous tissues of the body generally, as in gonorrhœal arthritis and sclerotitis, and in that the micro-organism, *gonococcus* (Fig. 369), found in the discharges after cultivations to four generations, will set up a similar inflammation in any mucous membrane to which it is applied. The cocci are arranged in pairs with the adjacent sides flattened against each other (*biscuit-shape*), and they are frequently included within leucocytes, and do not stain by Gram's method, nor do they grow on any of the ordinary media. In the male, gonorrhœa usually begins in the mucous membrane of the fossa navicularis, and, if allowed to run its course, extends backwards along the urethra, and thence may spread to the vesiculæ seminales, prostate, bladder, and testicle. In the female it usually begins about the vulva, whence it may extend to the vagina, and more rarely to the urethra, bladder, uterus and Fallopian tubes.

Symptoms.—Gonorrhœa is generally divided into three stages. In the *first stage*, usually lasting from a few days to a week, there is some itching about the external meatus followed by a yellowish-white discharge. In the *second or acute stage*, there is great pain on urination, a thick yellowish-green discharge, and redness and swelling about the lips of the meatus. In the *third or chronic stage*, which, when prolonged, is known as *gleet*, the discharge becomes thin and watery, and there is no longer pain on urination.

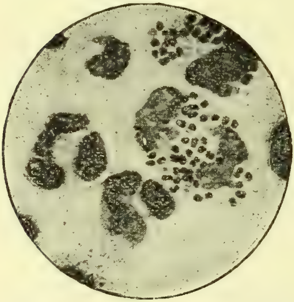

FIG. 369.—Gonococci. × 1000. (After Sternberg.)

The *treatment* varies according to the stage of the disease. Generally it may be said that at the onset a smart purge should be given, and the bowels subsequently kept slightly relaxed by saline aperients; whilst, throughout its course, stimulants of all kinds must be withheld, demulcent drinks freely taken to dilute the urine, the parts kept scrupulously clean, the testicles supported in a suspensory bandage, and active exercise and exposure to cold and wet avoided. Attempts should be made to confine the inflammation to the anterior part of the urethra by getting the patient to pass water, and thus irrigate his urethra before any local application is made. In the *first stage* the so-called abortive treatment is often successful. It consists in the use of astringent injections, and the internal administration of such drugs as copaiva, cubebs, or sandal oil. An excellent plan is that suggested by Mr. Cheyne of passing a bougie composed of iodoform, oil of eucalyptus, and oil of theobroma, into the urethra after the patient has passed water, and allowing it to dissolve there, and subsequently injecting freely with a lotion of sulpho-carbolate of zinc. The bougie should be repeated if necessary. In this way the disease may often be cured in a few days. In the *second stage* most surgeons recommend a soothing plan of treatment, merely keeping the bowels relaxed, and giving such medicines as hyoscyamus, bicarbonate of potash, &c. Unless, however, the inflammation is very intense, injections of sulpho-carbolate or sulphate of zinc, or of tannic acid, may be safely used, and will greatly lessen the duration of the disease. In the *third stage*, astringent injections, combined with the internal use of copaiva, cubebs, or sandal oil, are indicated. This stage is often very difficult to cure, and where one remedy or injection fails, another must be tried. The passage of a full-sized bougie is at times of much service. Spring bougies coated with thallin have been lately highly recommended.

COMPLICATIONS OF GONORRHŒA.—Complications of some kind frequently occur during an acute attack of gonorrhœa. They may be conveniently classified according as they depend upon:—A. *The local inflammation of the urethra*—1, balanitis; 2, chordee; 3, phimosis; 4, paraphimosis; 5, lacunar and perineal abscess; 6, retention of urine; 7, warts; 8, stricture; 9, induration of the penis (rare). B. *The extension of the inflammation along the genito-urinary mucous membrane*—1, prostatitis; 2, cystitis; 3, Cowperitis; 4, vesiculitis; 5, epididymitis; 6, pyelitis and nephritis (very rare); and in the female: 7, metritis; 8, salpingitis; 9, pelvic peritonitis and cellulitis. C. *The extension of the inflammation to the lymphatics of the urethra*—1, lymphangitis; 2, bubo, and 3, blood-poisoning. D. *The local inoculation of distant mucous membranes with the discharge*—1, gonorrhœal conjunctivitis; 2, nasal catarrh; and 3, catarrhal inflammation of the rectum. E. *The absorption by the blood-vessels of the septic products*—1, gonorrhœal rheumatism (so-called); 2, gonorrhœal sclerotitis; and, 3, septicæmia and pyæmia. Of these complications, some are exceedingly rare, whilst others, as *balanitis*, *chordee*, *phimosis*, *paraphimosis*, *epididymitis*, *bubo*, and *stricture* are common. Most of these complications are described under Diseases of the Various Organs in other parts of the book. Here a short account of the following only will be given.

BALANITIS, or inflammation of the glans penis, often occurs in gonorrhœa. The glans is red and swollen, of a bright red colour, and often excoriated. Cleanliness and astringent lotions are all that is necessary.

CHORDEE, or painful erection of the penis, is very common in gonorrhœa. The erected penis has often a downward curve, which is generally believed to depend on the inflammatory products in and around the urethra preventing the corpus spongiosum from becoming distended equally with the corpora cavernosa. Some, however, attribute the chordee to spasm of the urethral muscles. It occurs chiefly at night-time when the patient is warm in bed, and greatly disturbs his rest. The *treatment* consists in the administration of such sedatives as potassium bromide or of camphor and opium in the form of a pill or a suppository, and the local application of cold, or a hot bath before going to bed.

COWPERITIS, or inflammation of Cowper's glands, sometimes occurs, and then usually late in the second stage of gonorrhœa. It may be known by the formation of a painful swelling on one or both sides of the middle line of the perineum. The swelling, at first hard, subsequently becomes soft and fluctuating as pus forms. It may be distinguished from ordinary perineal abscess by its one-sided position. *Treatment.*—Warmth to the perineum, and, when suppuration has occurred, a free incision.

LYMPHANGITIS AND BUBO.—The inflamed lymphatic vessels appear as red streaks running along the dorsum of the penis to the inguinal glands, the penis itself, especially the glans, being swollen, turgid, and dusky red in colour. It may terminate in suppuration of the inguinal glands, or even in blood-poisoning. In the ordinary *gonorrhœal bubo*, inflamed lymphatics are not as a rule visible on the penis, and the inflammation which may occur both in and around the glands generally terminates without suppuration. *Treatment.*—Rest, and attention to the bowels, is all that is usually required. If, however, suppuration threatens, hot boracic poultices and fomentations must be applied, and a free incision in a vertical direction made as soon as pus forms. Should a sinus remain after the bubo has been opened or burst spontaneously, it should be laid freely open, scraped and stuffed with aseptic gauze, that it may heal from the bottom.

Gonorrhœal arthritis is described under Diseases of Joints (p. 236).

Stricture of the Urethra.

TRUE, OR ORGANIC STRICTURE OF THE URETHRA is a cicatricial narrowing of the canal at one or more spots due to disease, injury, or congenital defect. A temporary narrowing of the urethra may also occur from spasm of the muscular tissue surrounding it, or from congestion of its lining membrane, conditions to which the terms *spasmodic* and *congestive* stricture are sometimes applied. Such, however, seldom occur without the co-existence of organic stricture. Obstruction of the urethra by a calculus, an enlarged prostate, or by pressure from without, as from an abscess or fractured pelvic bone, should not be spoken of as stricture.

Cause and formation of stricture.—A stricture is generally the result of chronic inflammation, such as a neglected gonorrhœa or gleet, or more rarely, a simple urethritis in a gouty subject. In such cases the mucous and sub-mucous tissue become infiltrated with inflammatory products, which are ultimately organized into fibrous tissue; and this again slowly contracts, narrowing the canal. More rarely a stricture may be caused by the contraction of a cicatrix following laceration or rupture of the urethra, produced by injury inflicted either from within, by the careless passage of instruments or the use of too strong injections, or from without, by kicks, falls, &c., on the perineum. Occasionally it may be due to the contraction of the cicatrix following a urethral chancre. In some instances no cause can be ascribed. A few cases are congenital.

Varieties.—Organic strictures have been divided (1) according to their cause, into *idiopathic* and *traumatic;* (2) according to their anatomical appearances, into *linear*, *annular*, *irregular* or *tortuous*, *bridle* or *pack-thread*, and *tunnelled*, terms which sufficiently explain themselves; (3) according to whether an instrument can or cannot be passed, into *permeable* and *impermeable;* (4) according to their behaviour, into *simple*, *sensitive*, or *irritable*, and *contractile* or *recurring;* and (5) according to their structure, into *fibrous*, *elastic*, and *cartilaginous*.

Situation. — Stricture may occur in any part of the urethra save the prostatic. It is generally said to be most common in the bulbous part of the spongy portion, but Otis and others maintain that it is most often found in the anterior part of the urethra, and that what have been considered deep strictures are only spasmodic conditions consequent upon the reflex irritation of the true stricture in front. In the penile portion of the urethra, strictures are usually multiple.

Results.—When a stricture, or indeed any mechanical obstruction to the free flow of urine from the bladder, such as a long prepuce, an enlarged prostate, a narrow meatus, &c., has existed some time, serious structural changes (Fig. 370) occur in the urinary apparatus on the proximal side of the lesion, *i.e.*, in 1, the urethra behind the stricture; 2, the bladder; 3, the ureters; and 4, the kidneys. Thus:—

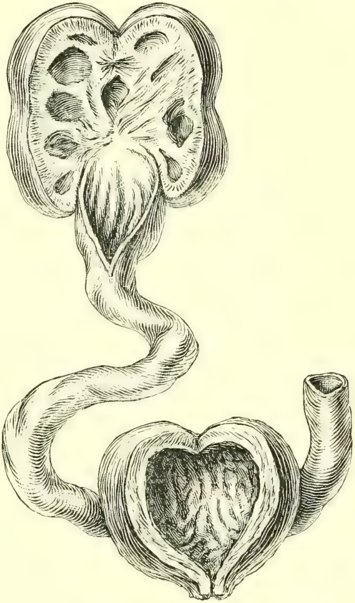

FIG. 370.—The effects of obstruction to the outflow of urine from the bladder on the urinary apparatus.

1. The *urethra* behind the stricture becomes dilated, and ulceration may occur leading to perforation, urinary abscess and fistula; or rupture may take place suddenly during straining, and be followed by extravasation of urine.

2. The *bladder*, in consequence of its efforts to expel the urine, becomes thickened from hypertrophy of its muscular coat. The

mucous membrane may become inflamed and thickened; or owing to the pressure of the urine may be protruded through the muscular fasciculi, forming sacculi, in which stale urine may collect or a calculus form.

3. The *ureters* become dilated, their muscular coats hypertrophied, and their lining membrane sometimes inflamed.

4. The *kidneys* become disorganised, in part from the backward pressure of the retained urine and in part from the spread of inflammation from the bladder up the ureter to the pelvis. See *Diseases of Kidneys*, p. 687.

Symptoms.—A gleety discharge, increased frequency of micturition, and perhaps, some pain in the act, twisting or forking of the stream, or the escape of a few drops of urine after the stream has ceased are early signs of stricture. Then the stream gets gradually smaller, and is passed with increasing difficulty and straining, till finally the urine may only be voided drop by drop, or complete retention may set in. In some instances an attack of retention is the first sign of the disease. In neglected cases the straining may produce piles or prolapse of the rectum ; or cystitis may be set up and the urine become ammoniacal and turbid from the presence of pus and mucus ; or the bladder may become over-distended, and the urine dribble involuntarily away. This condition of overflow should be carefully distinguished from incontinence (see p. 721). At first there are usually no constitutional symptoms ; but as the obstruction begins to tell on the bladder and kidneys, dyspeptic troubles are developed ; the patient loses weight, his countenance becomes anxious, he suffers from chilliness and occasional rigors, from pain in the loins, and later, from feverish attacks and unmistakable signs of kidney mischief. Thus a stricture which in itself, if kept properly dilated, is not a serious disease, becomes so when neglected and chronic bladder and kidney trouble are allowed to be set up. It may then end fatally from an intercurrent attack of acute cystitis or nephritis, or from extravasation of urine and its consequences occurring during an attack of retention.

A *diagnosis* can only be made with certainty by examining the urethra with instruments. First take a No. 8 or 9 black bougie or catheter and if this passes easily try successively larger sizes till the obstruction is met with. If, on the other hand, it will not pass, try a smaller bougie till one is found that will go into the bladder. If the obstruction to the passage of the bougie is met with within six inches of the meatus, a stricture exists ; but if it is further than this the case is one of enlarged prostate. Do not mistake the catching of the end of the bougie in a lacuna or at the triangular ligament, or the spasm that may be present on the first trial, for a stricture. Having discovered the stricture, measure the distance from the meatus on the catheter or bougie. Next pass a bulbous stem (Fig. 371) through the stricture, and then withdraw it, noting on the stem where the bulb is caught in the act of withdrawal. This, when compared with the distance noted on the catheter, will indicate the length of the stricture. In the same way the existence of other strictures can be discovered. The calibre of the stricture may be measured by Otis' urethrometer (Fig. 372).

The method of passing a bougie or catheter can be much better learnt by five minutes' practice than by any written instructions. Here only the general rules for passing such will be given. 1. Carefully examine the instrument to see that it is quite clean, perfectly smooth, not defective in any part, and, in the case of a catheter, that it is pervious, in order to avoid respectively the dangers of septic infection, laceration of the urethral mucous membrane, the breaking off of the end of the catheter in the stricture, and the annoyance of finding that when the catheter has been passed it is choked and urine will not flow through it. 2. Warm and oil the instrument; a cold catheter is unpleasant to the patient, and tends to produce spasm; an unoiled catheter does not glide easily along the urethra. 3. Place the patient in the recumbent position if instrumentation is to be practised for the first time, lest faintness be produced. In old-standing cases, where the urethra is callous, the patient may stand with his back against a wall. 4. Pass the instrument with the greatest gentleness and use no force.

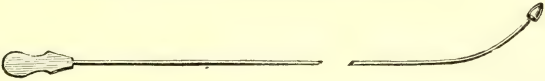

FIG. 371.—Bulbous stem.

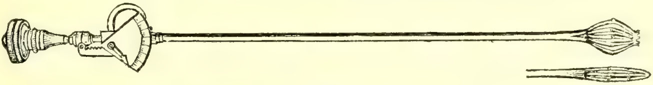

FIG. 372.—Otis' urethrometer.

The difficulties that may be met with in passing an instrument are: 1. The point may catch in a lacuna or fold of mucous membrane. This is best avoided by keeping the point at first on the floor of the urethra. 2. It may hitch where the urethra passes through the triangular ligament. Should it do so, withdraw it a little, and direct the point against the roof of the urethra. 3. It may enter a false passage. This may be known to have occurred (*a*) by the handle being deflected from the middle line, (*b*) by the catheter being felt to be out of the right passage by the finger in the rectum, (*c*) by free bleeding if the false passage is recent, (*d*) by no urine escaping, (*e*) by the point not moving freely as it does when in the bladder. The formation of a false passage may be prevented by using no force; and entering an old one may be avoided by using a silver catheter and directing its point along the wall of the urethra opposite to that in which the opening into the false passage is situated.

The local and constitutional effects that occasionally follow the introduction of instruments.—Among the *local effects* may be mentioned—1, hæmorrhage; 2, false passage; 3, abscess; 4, extravasation of urine, and 5, inflammation of the prostate, testicle, or bladder. Among the *constitutional effects*—1, syncope; 2, rigors; 3, urethral fever; 4, suppression of urine; and 5, pyæmia. *Local effects*—1, Hæmorrhage may be due to laceration of the mucous membrane of the urethra by the careless passage of the instrument, or to congestion of the urethra in the neighbourhood of the stricture; in either of these cases the blood may flow on the removal of the catheter, the point of which, moreover, will be blood-stained. Hæmorrhage, however, may come from the kidney consequent upon reflex congestion due to the irritation of the neck of the bladder by the catheter. The blood will then only appear in the urine after some time has elapsed (see *Hæmaturia*, p. 722). 2. A false passage may be produced by using too much force, or by applying force in the wrong direction. It is known to have been made, by the catheter being felt to slip suddenly onwards, by the handle deviating from the middle line, by the point being felt out of the urethra by the finger in the rectum, and by the patient complaining of severe pain. The catheter should be at once withdrawn and not passed again for a week or more to allow the wound to heal. 3. Abscess; 4, extravasation of urine; and 5, inflammation of the prostate, testicle, and bladder require no comment here. *General effects.*—1. Syncope occasionally occurs on the first passage of a catheter. It is best avoided by passing the instrument with the patient in the recumbent posture. 2. The rigors which sometimes follow the first introduction of an instrument appear to depend upon some nervous shock, and may occur where all gentleness has been employed and no local injury whatever has been inflicted. 3. Urethral fever is most frequent in old people, and may supervene within a day or two of the first catheterization. It begins with rigors followed by high fever, and usually terminates in a few days with profuse sweating. Occasionally, however, it may end fatally, in which case there is nearly always some chronic kidney disease discovered at the autopsy. Sir Andrew Clark has called attention to the possible occurrence of death after the passage of an instrument in old men without any kidney or bladder trouble to account for it. 4. Where suppression of urine has been observed there has always been some pre-existing kidney mischief. 5. Pyæmia is rare, but has occasionally been noted.

The *treatment* of organic stricture resolves itself into restoring the patency of the urethra by causing the absorption and destruction of the inflammatory or cicatricial material producing the obstruction, and subsequently preventing recontraction. The methods employed for restoring the patency of the urethra are: 1. *Slow dilatation.* 2. *Rapid dilatation.* 3. *Forcible dilatation or splitting.* 4. *Division of the stricture from within* (internal urethrotomy). 5. *Division of the stricture from without* (external urethrotomy). 6. *Destruction of the stricture by caustics.* 7. *Electrolysis.* Treatment by caustics may be said to have now become obsolete, and will not be further referred to. Of the other methods slow dilatation is no doubt the simplest and safest, and is the one that in the large majority of cases should be used. Where, however, time is an object, or the stricture cannot be dilated by the slow method beyond the size of a No. 4 or 5 catheter, or severe constitutional or local symptoms are set up on each occasion that a catheter is passed, rapid dilatation may be tried. Where again the continual presence of a catheter in the urethra cannot be borne on account of the local irritation which it causes, or the stricture is resilient and rapidly recontracts after it has been fully dilated, internal urethrotomy may be practised, especially if the stricture is in the penile portion of the urethra. Further, when the stricture is of cartilaginous consistency, and will not yield to dilatation, or the perineum, in addition, is riddled with sinuses, external urethrotomy by Syme's or Wheelhouse's method may be performed. Lastly, when, after persistent attempts, it is found that an instrument cannot be passed through the stricture, external urethrotomy by Wheelhouse's method may be undertaken. When the symptoms are urgent, as from retention or extravasation of urine, other measures may be required. See *Retention and Extravasation of Urine* (pp. 744 and 746). Forcible dilatation or splitting and electrolysis do not commend themselves to my judgment, and should not in my opinion be employed.

If a catheter will not pass on the first attempt it must not at once be assumed that the stricture is impervious, as it may yield on a future occasion; but gentle and persevering attempts with fine catgut bougies, filiform bougies, French silk bougies, or whalebone bougies, should be made. The patient, pre-supposing there is no retention, may be asked to pass water, and whilst the urine is flowing, and the stricture is in consequence dilated by the stream, a bougie one or two sizes smaller than the stream may sometimes be slipped in. If the point of a catheter is firmly grasped, indicating that it is in the mouth of the stricture, gentle pressure may then be used to push it onwards. If in any of these ways a fine bougie can be got in it should not be removed till the patient is compelled to pass water, when a small catheter may be subsequently substituted for it, or a railway catheter slid over the bougie before the latter is removed. If after persevering attempts, even with the patient under the influence of chloroform, success is not attained, the patient should be prepared for a further trial by rest in bed for a week or so, daily hot baths, purgatives, and the administration of opium. These means having failed, a cutting operation, of which Wheelhouse's is, in my opinion, the best, must be performed.

SLOW OR INTERMITTENT DILATATION is the simplest and safest method of treatment, and does not usually necessitate the patient leaving his ordinary employment. The various catheters and bougies employed are so well known as hardly to require description here. All that need be said is that the soft, flexible, black French bougie, with a bulbous end, is now as a rule generally preferred to a metal or gum-elastic instrument. A bougie or catheter should be passed once or twice a week, beginning with the largest instrument that can be introduced without using force. On the next occasion the same instrument should be again passed and at once withdrawn, and the next size substituted for it, and allowed to remain for a few minutes. In this way the urethra is gradually dilated to its full size. Formerly it was not thought necessary to pass a larger instrument than No. 12, English scale; now, however, few surgeons are satisfied till the dilatation has been carried to the size of No. 14. To prevent recontraction the patient should be taught to pass a catheter for himself, and instructed to do so at first once a week, then every month or six weeks, and subsequently two or three times a year, according to the tendency the stricture may show to recontract.

RAPID OR CONTINUOUS DILATATION is very useful: 1, when time is an object; 2, when much difficulty has attended the introduction of an instrument owing to the tightness of the stricture or presence of a false passage; 3, when the passage of an instrument causes great pain, irritation, hæmaturia, or rigors; 4, when gradual dilatation has failed. It consists in tying in a silver catheter for twenty to forty-eight hours, and, on removing it, tying in a size or two larger, and so on till the urethra is fully dilated. The instrument should not fit the stricture too tightly, and its end should not project far into the bladder. It is better, as soon as the stricture begins to yield, to substitute a gum-elastic for a metal instrument. This method necessitates confinement to the couch or bed for ten days or a fortnight, and is not unattended with risk. It frequently causes great pain; and rigors, fever, urethritis, cystitis, epididymitis, and ulceration of the bladder from the irritation of the point of the catheter, may be induced by it. If the catheter merely causes pain, opium may be given, or the urethra be injected with a solution of cocaine; whilst if it produces rigors, fever, cystitis, &c., it must be removed. It is generally believed that the mere presence of a catheter in the stricture causes the absorption of the inflammatory material in the submucous tissue, and that this result is not effected by mechanical stretching, since a catheter that does not fit the stricture tightly answers better than one that does, and causes less irritation. The method of tying in a catheter will be learnt by every student whilst dressing.

FORCIBLE DILATATION, SPLITTING OR RUPTURE (*Holt's operation*) is done by passing through the stricture an instrument consisting of two parallel blades with a central stem fixed between them, and then over this stem forcing a tube the size of the urethra, thus separating the blades and splitting or rupturing the stricture. The operation is not unattended with danger, and is more liable to be followed by an early relapse than either rapid dilatation or internal urethrotomy. Indeed internal urethrotomy has now to a great extent taken its place in the treatment of linear, contractile, and penile strictures (the strictures to which splitting was said to be especially adapted), since the cicatrix following laceration of the tissues is much more prone to contract than that following a clean cut.

INTERNAL URETHROTOMY, or division of the stricture from within the urethra, should only be undertaken when the simpler and safer method of treatment by dilatation has failed. It consists in making a clean longitudinal cut, with a guarded knife, completely through the stricture, and subsequently in keeping the edges of the wound apart by the passage of a full-sized bougie till the ovoid gap thus left has been filled with new tissue—*the cicatricial splice* of the American surgeons. The cicatrix following a clean cut shows much less tendency to contract than a cicatrix following a laceration or rupture; hence the superiority of internal urethrotomy over the method of *splitting or rupture.* The cases in which it is advocated are: 1. Intractable strictures that cannot be dilated beyond the size of a No. 5 or 6 catheter. 2. Strictures which rapidly recontract after dilating instruments are discontinued. 3. Cases in which the passage of instruments is constantly followed by retention of urine, hæmaturia, rigors, urethral fever, or other constitutional symptoms. But it is very questionable if external urethrotomy is not the better operation for these last conditions. Internal urethrotomy is especially applicable to strictures within three or four inches of the meatus. Anæsthesia of the urethra should be induced by injection with a 20 per cent. solution of cocaine. The operation may be done by cutting—1. From before backwards; and 2. From behind forwards. The latter method requires that the stricture should be dilated up to the size of a No. 4 or 5 catheter to enable the sheathed blade of the instrument to be passed through it; the former can be done if the stricture will admit a No. 2 catheter. There are many ways of performing both methods. The following appear to be the best:—

1. *Internal division of the stricture from before backwards.*—If the stricture is sufficiently near the meatus it may be simply divided by a straight blunt-pointed bistoury; otherwise Teevan's urethrotome (Fig. 373), which is a modification of Maisonneuve's, or Berkley Hill's instrument should be used. Teevan's consists of a slender staff A with an open slot running along it to within two inches of its end. Within this staff is fitted a stylet B. The slender olivary bougie C is first wriggled through the stricture into the bladder; the staff A is then screwed on to the bougie and made to follow it, the bougie coiling up in the bladder. When the stylet is withdrawn the urine will escape if the instrument has passed into the bladder and not into a false passage. The knife D, covered by the sheath E, is then placed inside the slot, and the stem of the sheathed knife is pushed down to the stricture. The knife is next protruded to half an inch, and then withdrawn in its sheath, which is pushed forward to see if the stricture is completely divided. If it be not, the process is repeated. Teevan divided the roof of the urethra to avoid the bulb, and the consequent danger of hæmorrhage from that structure. As soon as the canal was free from one end to the other he passed a full-sized silver catheter to prove that the calibre of the urethra had been restored, and completely emptied the bladder. He advised that a catheter should not be left in, and no instrument passed for four days.

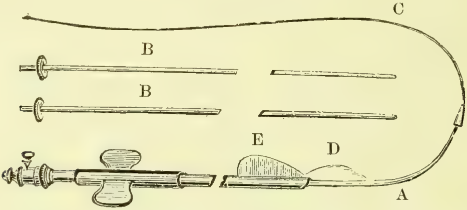

FIG. 373.—Teevan's urethrotome. A, staff; B, B, stylets; C, olivary bougie; D, knife; E, knife-sheath.

2. *Internal division of the stricture from behind forwards.*—(*a.*) Sir Henry Thompson uses a modification of Civiale's urethrotome (Fig. 374). He first dilates the stricture to the size of No. 4 or 5 bougie; then passes the bulb of the urethrotome, which contains the guarded knife, about a third of an inch beyond the stricture; protrudes the knife by a suitable arrangement in the handle, and draws it firmly towards the meatus for about an inch and a half, dividing the stricture along the floor of the urethra, and a little of

the healthy mucous membrane at each end of it. He then passes a No. 14 or 16 bougie, and if this is felt to be held at any point, re-introduces the urethrotome, and divides what remains of the stricture. A No. 12 gum-elastic catheter is then tied in for twenty-four to forty-eight hours. (*b.*) Dr. Otis uses what he calls a dilating urethrotome (Fig. 375). It is introduced beyond the stricture, the screw at the handle is turned, dilating the instrument up to a millimetre or two beyond the normal calibre of the stricture in order to make the latter completely salient. Then the blade is drawn through the stricture, dividing it from behind forwards. Otis claims that when the stricture has been completely divided, re-contraction does not occur. This, however, would appear to be contrary to the experience of surgeons generally, the stricture returning (though less rapidly), as it does after all methods of treatment, if a bougie is not occasionally passed.

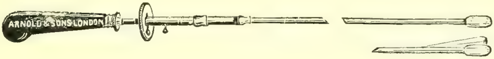

Fig. 374.—Thompson's modification of Civiale's urethrotome.

For strictures in front of the scrotum, internal urethrotomy is a very successful operation; but in deeper situations it has been followed by abscess, severe hæmorrhage, extravasation of urine, cystitis, nephritis, and pyæmia. It would appear to be attended with a mortality ranging from 1 to 3 per cent.

External urethrotomy, or opening the urethra from the perineum, may be required for two distinct conditions. 1. For certain strictures which, though pervious to instruments, are of an intractable nature. Here the operation known as Syme's should be done. 2. For strictures through which, even after the utmost perseverance, an instrument cannot be passed. In these cases the stricture may be divided by Wheelhouse's modification of the old method of perineal section; or the urethra may be opened by Cock's method, *i.e.*, behind the stricture at the apex of the prostate, and the stricture left undivided in the hope that, relieved from the pressure and irritation of the urine, it may become pervious to instruments.

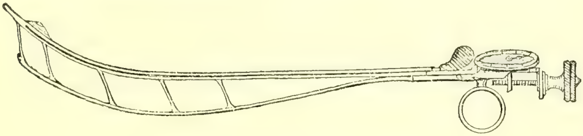

Fig. 375.—Otis' urethrotome.

Syme's method of external urethrotomy or perineal section.—Syme advises this operation for—1, irritable, and 2, contractile strictures "that are indomitable by the ordinary means of treatment." For such, however, internal urethrotomy is now generally preferred, and Syme's operation reserved for 3, indurated and cartilaginous strictures, complicated by intractable perineal fistulæ where dilatation has failed. Introduce Syme's shouldered staff (Fig. 376) so that the slender part passes through the stricture into the bladder, and the shoulder of the thicker part rests against the face of the stricture. Place the patient in the lithotomy position, and make an incision one inch and a quarter long, through the middle line of the perineum, over the stricture. Having felt the staff distinctly in the wound, take it in the left hand, "and guarding the knife with the right forefinger, insert its point into the groove on the bladder side of the stricture, and divide the stricture from behind forward. When completely divided, the thicker part of the staff can be pushed on into the bladder." A full-sized catheter should be tied in for twenty-four hours. The difficulties attending Syme's operation are—1, to be sure that the staff is in the bladder, and not in a false passage; and 2, to pass a catheter afterwards. These are obviated by the modification suggested by Teevan. He advises a catheter-staff with a groove on its convexity, along which the knife can be run to divide the stricture. When introduced, it is known to be in the bladder by the escape of urine on removing the stylet. A bougie is then screwed on to its end, and a gum-elastic railway catheter is passed over the bougie and staff till arrested by the stricture, and is there fixed by a screw. When the stricture is thought to be divided, the catheter is advanced over the staff; and if all is divided, will pass on into the bladder. The catheter-staff can now be withdrawn, and the catheter, if desired, left in the bladder. Syme's operation is very useful, but like other methods, is liable to be followed by re-contraction if a bougie is not occasionally passed.

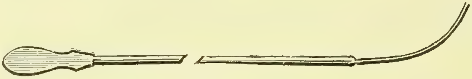

FIG. 376.—Syme's staff.

Perineal section must not be confounded with Syme's operation, to which this term is sometimes applied. The older operations of perineal section were performed by cutting into the urethra either in front of or behind the stricture, and then trying to divide the stricture without a guide. They were the most difficult operations in surgery. The stricture was often missed altogether and an incision made by its side, and the greatest difficulty was experienced in finding the proximal end of the urethra. Indeed, after a long search the surgeon had often the mortification of having to send the patient back to bed without having succeeded in reaching the bladder. These difficulties have to a great extent been overcome by Mr. Wheelhouse, who, instead of cutting down upon the end of the staff on the face of the stricture, opens the urethra *half an inch in front* of it, and passes a director through the opening thus made in the urethra into the stricture and divides the latter.

Wheelhouse's modification of perineal section.—Pass Wheelhouse's staff (Fig. 377), with the groove downwards, to the stricture. Place the patient in the lithotomy position with the pelvis raised so that light may fall into the wound. Make an incision in the middle line of the perineum, and open the urethra on the groove (not on the point of the staff), so as to be *half an inch* in *front* of the stricture. Seize the edges of the healthy urethra on each side by artery forceps, and hold them apart. Withdraw the staff a little, turn it so that the groove looks towards the pubes, and catch up the upper angle of the opened urethra by the hooked end. The urethra is thus held open at three points (Fig. 378). Search for the stricture, and pass a slender probe-pointed director through it into the bladder. Divide the stricture with a probe-pointed

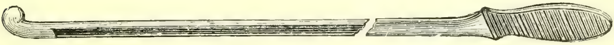
FIG. 377.—Wheelhouse's staff.

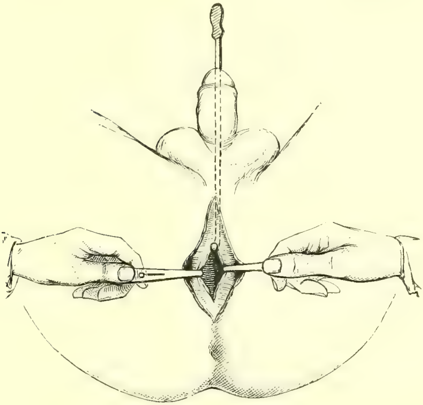
FIG. 378.—Wheelhouse's method of opening urethra. (Bryant's Surgery.)

bistoury run along the groove in the director. Pass the point of the probe-gorget (Fig. 379) along the groove of the director towards the bladder, dilating the divided stricture. Introduce a gum-elastic catheter from the meatus into the wound, and guide it by the gorget into the bladder. Withdraw the gorget, and retain the catheter in the urethra for three or four days. The catheter should allow a catgut bougie to pass through it to act as a guide when it has to be changed.

Cock's operation of perineal section, or tapping the dilated urethra at the apex of the prostate "unassisted by a guide staff." Secure the patient in the lithotomy position. Pass the left forefinger into the rectum, and place its point on the apex of the prostate. Plunge a double-edged scalpel (Cock's knife), or, if preferred, a blunt-backed knife, boldly into the median line of the perineum, and carry it towards the tip of the finger in the rectum. Enlarge the incision by an upward and downward movement of the knife, but do not withdraw it. When the point is felt near the tip of the finger, press it onwards into the urethra. Withdraw the knife, keep the finger in the rectum, and guide a probe-pointed director into the bladder. Withdraw the finger from the rectum, and pass a cannula along the director into the bladder, and tie it in for a few days. This appears to be a good operation for impervious stricture with fistulæ and much induration of the perineum, and is held in considerable favour by some of the Guy's surgeons. For such strictures, however, Wheelhouse's operation is more generally performed.

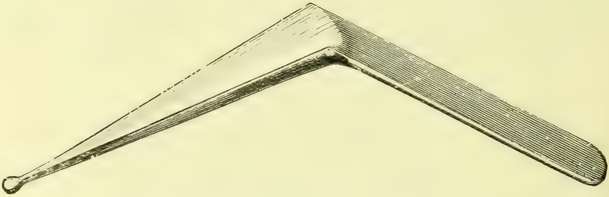

FIG. 379.—Wheelhouse's probe-gorget.

Electrolysis consists in passing a catheter-electrode down to the face of the stricture, connecting it with the battery, and applying the other electrode to some other part of the body. It is believed to act by causing some chemical change in the cicatricial tissue, thus leading to its absorption. It is certainly not unattended with danger—extravasation of urine and even death having followed its employment, and does not possess any advantage over other and safer methods.

Urethral or urinary abscesses may occur at any part of the urethra, but the most common situation is in the perineum. *Cause.*—They are most often formed in connection with stricture, and are then due to ulceration and local extravasation of urine behind the seat of obstruction. They may also result from injury inflicted either from without or from within, as passing an instrument along the urethra, or the impaction of a calculus; or they may occur during an attack of gonorrhœa from inflammation extending to one of the urethral follicles or to Cowper's glands. The *signs* of a urethral abscess in the perineum, its most common situation, are the presence of a hard, brawny, deeply-seated swelling, generally beginning in the middle line just in front of the anus, and as it increases in size, making its way to one or other side of the perineum in the direction of the groin. At first, while the pus is bound down by the deep fascia, there is no fluctuation, and it is only as it approaches the surface that this sign of abscess can be detected. The abscess is attended with throbbing pain, often with sharp constitutional disturbance, and occasionally with a rigor; it may also cause retention of urine. *Treatment.*—Fluctuation must not be waited for, but a catheter passed down the urethra, and a free incision made in the median line of the perineum into the swelling, and the finger passed into the bladder. If the abscess is not opened, it may break externally on the perineum, or it may burrow amongst the tissues and break into the rectum; and if not already in connection with the urethra, as when the abscess forms external to it, it may break into that canal.

URINARY FISTULÆ are generally the result of urinary abscess in connection with stricture of the urethra. They may also be due to wounds of the urethra, made accidentally, or by surgical operation, or to ulceration following impaction of a calculus. They are commonly divided into three kinds:—1, The *perineal;* 2, the *scrotal;* and 3, the *penile.* The perineal may be single or multiple; the scrotal are nearly always multiple; and the penile single. In long-standing cases the fistulæ may burrow among the tissues of the groin, nates, and thighs, and may even open into the rectum.

Treatment.—When due to stricture, the fistulæ will generally readily heal when the stricture is cured and a free natural passage is established for the escape of urine. Should they not do so—1. A *perineal fistula,* when small, may be induced to close by passing a soft catheter to prevent the contact of urine whenever the patient micturates, or by inserting into the fistula a hot wire or a probe coated with silver nitrate. If these means fail, the edges of the fistula may be pared and brought together by sutures. When the parts are indurated and the stricture is of the cartilaginous kind, external urethrotomy and laying open of the fistula should be practised. 2. *Scrotal fistulæ* nearly always require freely laying open, and when secondary fistulæ extend to the groin or buttock, they should also be treated in this way. 3. *Penile fistulæ* when large, and especially when the result of sloughing consequent upon the impaction of a calculus, usually require a plastic operation.

EXTRAVASATION OF URINE is commonly, though not always, the result of stricture, and is then due either to the dilated urethra behind a stricture ulcerating and giving way, or to a lacunar abscess bursting into the urethra. In either case, the urine is forced by the contraction of the bladder into the surrounding cellular tissue. The urethra may give way (1) in front of the anterior layer, (2) between the two layers, and (3) behind the posterior layer of the triangular ligament. In the first, and by far the most common, situation, it is the bulbous portion of the urethra that gives way. Here the urine is prevented from passing —1, backwards into the pelvis by the anterior layer of the triangular ligament being attached to the rami of the pubes and ischium and sub-pubic ligament; 2, downwards into the ischiorectal fossa by the anterior layer of the triangular ligament being continuous around the transverse perineal muscle with the deep layer of the superficial fascia of the perineum; 3, laterally on to the thighs by the deep layer of the superficial fascia of the perineum being attached to the rami of the pubes and ischium. Hence it passes in the middle line into the cellular tissue of the scrotum and penis, and laterally on to the abdomen, where it is prevented from passing down the thigh by the deep layer of the superficial fascia of the groin (which is continuous with the deep layer of the superficial fascia of the perineum) being attached along the line of Poupart's ligament. When the *membraneous portion* of the urethra is ruptured, the urine is confined at first between the two layers of the triangular ligament, and if not let out will make its way (1) forwards, through the anterior layer, and take the course as given above, or rarely (2) backwards, through the posterior layer, and then, as when the urethra gives way behind the posterior layer, will make its way around the neck of the bladder, and will be almost inevitably fatal. Wherever the urine spreads, it causes inflammation and sloughing.

Symptoms.—The history of a case of extravasation is not uncommonly as follows. A patient with a tight stricture is straining to pass water, he feels something give way, experiences a sensation of relief, and perhaps owing to the tension being removed by some urine being forced into the cellular tissue, the superadded spasm for a time ceases, and a few ounces of urine are passed through the urethra. In half an hour or so a pricking or burning sensation is felt in the perineum, soon followed by pain and by rapidly increasing swelling of the perineum, scrotum and penis.

If the urine is not let out by timely incisions the swelling extends to the groin, and in some cases has been known to reach as high as the axilla. The skin now appears dusky or purplish-red and œdematous, and gangrene and sloughing of the infiltrated tissues rapidly ensue. The absorption of the septic products gives rise to constitutional disturbance and fever, which though it may at first run high, soon assumes a low typhoid character, and the patient, especially if the subject of chronic kidney disease, frequently sinks into a comatose state and dies. When the extravasation occurs between the two layers of the triangular ligament, it may remain localized, giving rise to a hard circumscribed swelling in the perineum, which may slowly make its way towards the scrotum; and lastly, when the extravasation occurs behind the posterior layer of the triangular ligament and the urine is extravasated into the pelvic cellular tissue, the symptoms resemble those of extra-peritoneal rupture of the bladder.

Treatment.—A catheter should be passed into the bladder, or where this is impossible, down to the stricture, and in either case a free incision in the middle line of the perineum extending into the urethra made on the catheter. Free incisions through the skin of the scrotum, penis, and groins, in fact, wherever the urine has penetrated, should likewise be made to allow of its draining away, and the wounds rendered as far as possible aseptic by the free application of iodoform or other antiseptics. The patient's strength at the same time must be supported by fluid nourishment and stimulants; whilst opium should be given, unless contra-indicated on account of kidney disease.

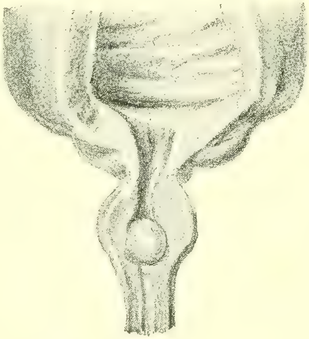

Fig. 380.—Calculus impacted in urethra. (St. Bartholomew's Hospital Museum.)

Stone in the urethra.—A small calculus or fragment of one may become impacted in any part of the urethra, but most frequently in the membraneous portion (Fig. 380), or just within the meatus. When sharp and angular it causes much pain, and when large enough to obstruct the urethra gives rise to retention, and, if not soon removed, to ulceration followed by extravasation of urine. *Treatment.*—If far forward, it may often be expelled, whilst straining to pass water, by holding the meatus and suddenly letting go; or gentle manipulation, aided, if necessary, by incision of the meatus, may suffice. Extraction by the urethral forceps should next be tried (Figs. 381 and 382), and this failing, a free incision over the stone must be made. Thus, if impacted in the membraneous portion, it should be removed through an incision in the middle line of the perineum; if in the penile portion just in front of the scrotum, it should be pushed back if possible into the membraneous portion and removed through the perineum, as an incision in the penile portion of the urethra is apt to be followed by a fistula, and should if possible be avoided. If compelled to incise the penile urethra the incision should be free so as to prevent laceration of the tissues in extracting the stone. The edges of the wound should then be united by suture, and a soft catheter tied in the urethra for a few days till the incision has healed.

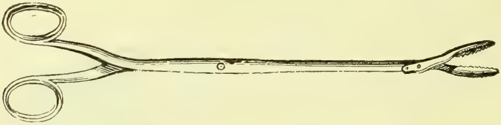

Fig. 381.—Urethral forceps (Arnold's).

Vascular tumours are much more frequent in the female than in the male urethra. In the female, they occur as small florid excrescences usually situated about the entrance of the urethra, often surrounding it like a ring and perhaps extending some distance up it. They give rise to increased frequency of micturition, pain during the act, and intermittent attacks of hæmorrhage, thus somewhat simulating the symptoms of a calculus; but inspection will at once reveal the nature of the affection. *Treatment.*—Ligature, or the application of nitric acid or the thermo-cautery, generally suffices for their cure.

Retention of urine, or inability to pass water, must be distinguished from suppression of urine in which none is secreted by the kidneys. *Cause.*—Retention may depend upon either (*a*) obstruction to the outflow of urine from the bladder, or (*b*) inability of the bladder to expel its contents consequent upon atony of its muscular coat or paralysis. Retention, therefore, is a symptom of several diseases. 1. In *the old*, it is commonly due to enlarged prostate with superadded congestion, combined with atony of the bladder from over-distension. 2. In *adult men* it may be due to organic stricture with temporary spasm of the unstriped muscular fibres of the urethra, or to congestion of the mucous membrane owing to gonorrhœa, a drinking bout, or cold and wet. 3. In *women* it may be the result of hysteria, or the pressure of an enlarged uterus

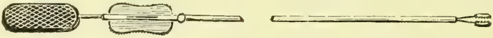

Fig. 382.—Hogan's urethral forceps.

or other pelvic tumour or of the fœtal head in parturition. 4. In *children* it is commonly caused by an impacted calculus or ligature of the penis, and more rarely by phimosis. 5. At *all ages* and in *both sexes* it may be due to reflex spasm after an operation on the rectum, shock following any severe injury or operation, a tumour in the neck of the bladder or urethra, and an abscess in any part of the urethra. It may also be due to paralysis consequent upon disease or injury of the brain or spinal cord, and to atony of the muscular coat of the bladder. In the two latter conditions, however, after the bladder has become distended and will hold no more, the excess of urine passively overflows, dribbling constantly away; and this condition of false incontinence must be distinguished from true incontinence, in which the urine runs away from the bladder as fast as it is secreted by the kidneys.

Symptoms and signs.—When retention has come on slowly, as from the gradual contraction of an organic stricture, there may be but little local pain and no constitutional disturbance, even although the bladder may be distended by many ounces of urine. Where, however, it is produced suddenly, there is usually great pain followed by severe constitutional symptoms—a small and frequent pulse, a dry and brown tongue, and perhaps delirium, symptoms probably due to the sudden check to secretion by the kidneys, and to the stretching of the bladder. The bladder itself, unless greatly hypertrophied and contracted, rises out of the pelvis, and may be felt as a distinct tumour, dull to percussion, and at times extending as high as the umbilicus, or in extreme cases even to the ensiform cartilage. The patient, unless drunk, usually complains of inability to pass water. When, however, the bladder has become gradually distended and urine is passively flowing away, he may complain of inability to hold his water, and be quite unaware that the bladder is full, and may object to have a catheter passed till the condition has been explained. The presence of a swelling in the abdomen, and the flowing of urine through the catheter immediately after the patient has passed water and believes that he has emptied his bladder, should serve for the diagnosis. In suppression, the bladder is found empty on passing a catheter.

Results of retention.—If the bladder is soon relieved no apparent harm may ensue. If neglected, however, the over-distension may lead to—1, atony of the muscular coat; 2, cystitis; 3, nephritis; 4, rupture of the urethra behind the obstruction; 5 (rarely), rupture of the bladder itself; and, 6, passive overflow of urine, the bladder remaining full.

Treatment.—The distended bladder must be relieved, and if the distension is extreme and the symptoms urgent, at once. The way of doing this will vary according to the cause, and will be considered under the following heads:—

1. *Retention from spasm of the unstriped fibres surrounding* the urethra, sometimes called *spasmodic stricture.* Spasm is rarely, if ever, sufficient, alone, to cause retention. Generally some slight organic narrowing of the urethra is also present. The usual history of retention from spasm is a drinking bout, or exposure to cold or wet in a gouty or rheumatic subject; while on careful questioning, the patient admits that the stream has been noticed to be small or forked, or that a similar attack of retention has previously occurred. If the retention has existed for some time, and there is much pain and considerable distension of the bladder, a full-sized flexible catheter (No. 8 or 9) should be passed, if necessary under chloroform. When, however, the symptoms are not urgent, and an instrument has never been passed, a hot bath and a full dose of tincture of opium will generally suffice. In retention due to spasm following operations, a well oiled soft-rubber catheter should be passed.

When the spasm is associated with a severe organic stricture other means may have to be taken. See *Treatment of Retention from Organic Stricture.*

2. *Retention from congestion of the mucous membrane* of the urethra, sometimes known as *congestive stricture.* Congestion, like spasm, is seldom sufficient of itself to produce retention; and is nearly always associated with at least a slight organic stricture or with some enlargement of the prostate. It is usually the result of gonorrhœa, or other conditions causing inflammation of the urethra. The treatment is similar to that of retention from spasm.

3. *Retention from hypertrophy of the prostate* only occurs after middle life. It is then generally due to congestion induced by cold, the abuse of alcohol, &c., causing the already existing obstruction to become complete. First, try to pass a No. 9 French single coudé catheter (Fig. 367), then a double coudé (Fig. 368), and these failing, a gum-elastic catheter with a large curve. Should the point hitch at the middle lobe of the prostate, withdrawing the stylet for half an inch will cause the end to slightly tilt up, and it will then often readily glide into the bladder. If not successful in this way the silver prostatic or the beaked catheter must next be tried, but serious mischief may be done by these instruments unless the greatest gentleness is used. They should never be employed until other forms have failed. If a catheter passes easily it may be withdrawn after the bladder is relieved; but if passed with difficulty it had better be left in, as more harm may be done by having to pass it again than by leaving it *in situ.* When the bladder is greatly distended all the urine should not be drawn off at once, lest syncope be induced. A catheter failing, the retention may be relieved by: 1, puncture above the pubes; 2, puncture through the rectum; and 3, forcing a catheter through the prostate (*tunnelling*). The first method is decidedly the best. The second is

seldom applicable, as the enlargement, as a rule, leaves no room between the prostate and the pouch of peritoneum for puncture, which, if attempted, will probably wound the peritoneum. The third method is attended with extreme danger, and is seldom practised at the present day.

4. *Retention from organic stricture.*—The symptoms and diagnosis of stricture have already been described. Here only need be mentioned the treatment to be adopted in cases of retention from this cause. An endeavour should first be made to pass a catheter, if necessary under an anæsthetic. If this fails, and the symptoms are not urgent, a hot bath and a full dose of tincture of opium may be given, and another trial made in a few hours. Where, however, there are signs of grave kidney mischief, opium must be withheld or given with great caution. Should these means not succeed, or if from the first the symptoms are urgent, one of the following methods may be resorted to, viz. : 1. Aspiration, or puncture of the bladder above the pubes; 2. Wheelhouse's operation; 3. Puncture of the bladder through the rectum; 4. Cock's operation of opening the urethra behind the stricture through an incision in the perineum; and 5. Forcing a catheter into the bladder. The last method is highly objectionable, and should on no account be practised. Of the other methods, aspiration above the pubes, repeated, if necessary, should the stricture not quickly yield after the spasm has been removed by emptying the bladder and thus reducing the tension, is in my opinion the best. Puncture through the rectum is strongly recommended by some surgeons; but it is open to the objection that suppuration between the bladder and rectum, extravasation of urine, and a permanent recto-vesical fistula, are liable to follow, to say nothing of the annoyance to the patient from the presence of the cannula in the rectum, and the excoriation of the parts by the urine, which, notwithstanding care, is apt to occur. The vas deferens, moreover, may be injured, and atrophy of the testicle ensue. Cock's operation is difficult to perform, and does not appear to possess any advantage over aspiration or puncture above the pubes. Should the passage of a catheter not be effected after the bladder has been aspirated on several occasions, Wheelhouse's operation should be undertaken. Aspiration, though as a rule attended with excellent results, is not absolutely free from danger. Thus it should not be practised when the urine is unhealthy, or the walls of the bladder are thinned and atonied, lest a drop or two escape through the puncture and set up septic inflammation and suppuration, which may be followed by extravasation of urine.

5. *Retention from hysteria* should be combated by such moral and physical treatment as is applicable to that disease. A catheter should not be passed if it can be possibly avoided. A hot sponge applied to the pubes is often successful.

6. *Retention from paralysis or atony of the bladder, from abscess or tumour of the urethra or bladder, from impacted calculus, and from ligature of the penis*, is discussed under the heads of Paralysis of the Bladder, Impacted Calculus, &c.

PUNCTURE OF THE BLADDER ABOVE THE PUBES (Fig. 305, b).—Make a small incision through the skin immediately above the pubes, having first ascertained by percussion that the bladder has risen well out of the pelvis, and thrust Cock's curved trocar and cannula downwards and backwards into the bladder. Withdraw the trocar, secure the cannula *in situ*, and pass through it a soft catheter connected with a long rubber tube to carry away the urine. In a few days, when the parts are consolidated, the cannula should be changed. When the bladder is distended, a good inch rises above the pubes uncovered by peritoneum, but when contracted and hypertrophied it may rise but little if at all. Under these latter cirumstances the trocar and cannula must be passed close to the pubes for fear of wounding the peritoneum.

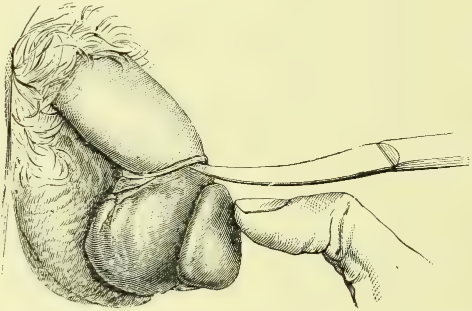

FIG. 383.—Method of dividing the stricture in paraphimosis. (Bryant's Surgery.)

Aspiration is performed in a similar way, except that the aspirating needle or trocar is thrust in without any preliminary incision of the skin. If a small aspirating needle or cannula is used there is no danger of extravasation, as on its withdrawal the puncture in the bladder is closed by the contraction of the muscular fibres; and even should a drop or two of urine escape no harm will ensue provided the urine is healthy. It is a most useful emergency operation, and, if necessary, may be repeated on several successive occasions.

PUNCTURE OF THE BLADDER THROUGH THE RECTUM.—Place the patient in the lithotomy position. Pass the left forefinger into the rectum, and place its tip just beyond the back of the prostate. Take Cock's long curved trocar and cannula, with the point of the trocar slightly withdrawn within the cannula. Introduce it through the anus, and guide it by the finger in the rectum to a spot immediately behind the prostate exactly in the middle line. Press the cannula firmly on the fluctuating trigone of the bladder, and plunge the trocar boldly into the bladder, in a direction upwards and forwards towards the umbilicus. Withdraw the trocar and secure the cannula *in situ* with suitable tapes. Do not plug the cannula, but fix an india-rubber tube on its end, and convey this to a vessel beneath the bed.

DISEASES OF THE GENITAL ORGANS.

DISEASES OF THE PENIS.

PARAPHIMOSIS is the strangulation of the glans penis by a tight prepuce which has been drawn back over it, and cannot be replaced. Thus, it is not infrequently met with in boys, from the accidental uncovering of the glans and neglect to draw the prepuce forward again. In adults it is generally due to swelling, caused by gonorrhœa or venereal sores, but it may occasionally occur during coitus. It is attended with great œdema of the glans and prepuce, and if not soon reduced may lead to ulceration at the line of constriction, or even to sloughing of the penis. *Treatment.*—Seize the penis between the first and second fingers of each hand, press the blood and œdema out of the glans with the thumbs, and at the same time push the glans backwards and try to draw the prepuce forwards over it. If this fails, divide with a knife (Fig. 383) the constricting band, which is formed by the orifice of the prepuce, and which lies just behind the fold of the œdematous mucous lining of the prepuce at the bottom of the furrow on the dorsum of the penis, taking care to avoid the subcutaneous veins, lest extensive subcutaneous extravasation of blood follow.

PHIMOSIS is a condition in which the prepuce is elongated, and its orifice contracted, so that it cannot be drawn back over the glans. It may occur as a congenital affection; or it may be acquired, and is then usually due to the cicatricial contraction of the orifice following syphilitic ulceration or repeated attacks of gonorrhœa. The orifice when very small may cause difficulty of micturition or even retention of urine; whilst the straining to pass water may induce prolapse of the rectum, hernia, irritation of the bladder and symptoms of stone, nocturnal incontinence, and sometimes even hæmaturia or symptoms of hip disease or spastic contraction of the lower limbs, and if not relieved may produce the harmful effects on the urinary organs described under stricture; or the deposit of the urinary salts beneath the prepuce may lead to the formation of preputial calculi. The inability to uncover the glans may cause pain and difficulty in coitus, and, by preserving a mucous membrane-like character to the glans, predispose to venereal disease; whilst the secretion which collects beneath the prepuce may, in consequence of the irritation it is apt to set up, induce priapism, habits of masturbation, inflammation sometimes simulating gonorrhœa, adhesion of the glans to the prepuce, or even as age advances the formation of an epithelioma. The *treatment* may be considered under the heads of—1, *circumcision;* 2, *slitting the prepuce;* and 3, *dilatation of the preputial orifice.*

1. *Circumcision.*—Lay hold of the prepuce transversely with a pair of Ricord's forceps, on a level with the corona (Fig. 384); let the glans slip back, close the forceps, and shave off the prepuce in front of them with a clean sweep of the knife. Remove the forceps, slit up the mucous lining of the prepuce in the middle line quite back to the corona, break down any adhesions between the prepuce and glans, wash away the secretion, remove the mucous membrane to within an eighth of an inch of the corona, twist or tie any spurting vessels, and stitch the remaining mucous membrane to the skin with interrupted horse-hair or catgut sutures (in infants no sutures are required). Dress with boracic lint or iodoform gauze.

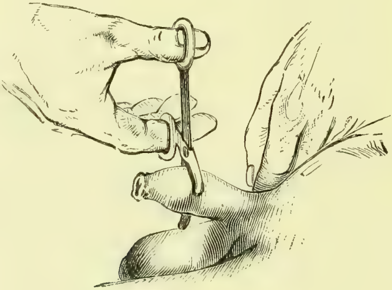

Fig. 384.—Seizing the prepuce preparatory to the operation of circumcision. (Bryant's Surgery.)

2. *Slitting the prepuce* may be done with scissors, or with a curved bistoury guided by a director, introduced between the glans and prepuce. In either case the mucous membrane should be united to the skin-flaps by fine sutures after twisting or tying any bleeding vessels. Care should be taken not to pass the director into the meatus, and to ensure that the mucous membrane is slit quite back to the corona.

3. *Dilatation of the prepuce* may be accomplished in slight cases by a daily endeavour to draw back the contracted prepuce over the

glans. It may also be done by the preputial dilator, or by forcible separation of the blades of the dressing forceps, though such means are not often successful.

Circumcision should be performed—1. If the preputial orifice is greatly contracted; 2. If the prepuce is very long; 3. If inflammatory changes are occurring beneath it; 4. If it is adherent to the glans so that it cannot be retracted; 5. If any of the usual sequelæ, as hernia, prolapse of the rectum, &c., are present.

PRIMARY VENEREAL SORES OR CHANCRES.—Two chief varieties of venereal sore or chancre occur, *the syphilitic* or *infecting*, and the *local contagious* or *non-infecting*. Either of these may be accompanied by sloughing or phagedæna, and is then spoken of as a sloughing or phagedænic sore or chancre.

1. *The primary syphilitic chancre* has already been described in the section on Syphilis (p. 51).

2. *The local contagious* or *non-infecting sore*, the *soft chancre* or *chancroid*, as it is sometimes called to distinguish it from the hard or syphilitic chancre, is a specific form of ulceration probably depending upon a distinct variety of micro-organism. Though the ulcer, like the syphilitic, may occur on any part of the body that is inoculated with the specific virus, it is so much more frequently met with on the genitals that it is described with diseases of these organs. It is not followed by constitutional symptoms.

Signs.—Non-infecting or soft chancres are most frequent at the junction of the glans and prepuce, where they often take the form of a ring of small ulcers around the corona glandis. More rarely they are met with on the muco-cutaneous or cutaneous surface of the organ. They usually begin as a small pustule or slight excoriation within a few days of inoculation, and, when fully established, appear as small oval ulcers, with sharply-cut edges and a slightly depressed base covered with a greyish slough, and surrounded by a red areola of inflammation. When irritated, as by the rubbing of the clothes, or the retention of the secretion beneath a long prepuce, they may become indurated; but the induration has not the sharply-defined character of the syphilitic sore. The inguinal glands become enlarged (*bubo*), and matted together into a single mass, often of considerable size, and have a marked tendency to suppurate. The pus taken from them apparently contains the same micro-organism as that of the sore, since when inoculated on the same or another person a similar sore is produced.

Diagnosis.—The main differences between a non-infecting or soft sore, and an infecting or hard, are the following.—The soft sore is generally unattended with induration; in the hard the induration is generally well marked. The soft occurs within a few days of inoculation; the hard not till after three to five weeks. In the soft the secretion is abundant and purulent; in the hard scanty, and often consists of little more than epithelial *débris*. The soft can be re-inoculated on the same patient, and hence is frequently multiple; the hard cannot be re-inoculated on the same patient, and hence is single unless, as very rarely happens, the patient is inoculated in two places at the same time. The bubo following the soft sore is single, soft, and very liable to suppurate; that following the hard sore is multiple, hard, and shotty, and very rarely suppurates. A patient, however, may be inoculated with syphilis at the same time that he receives a soft sore. Hence, when the incubative period of syphilis has passed, the soft sore may take on the characters of the hard sore. Till this period is over, therefore, a cautious prognosis as to the probable occurrence of secondary symptoms should be given. It is consequently not uncommon to find a patient with a chancre which presents characters both of the hard and soft sore. A soft sore must also be distinguished from a crop of hepatic vesicles. The latter are small, numerous, and grouped close together, there is usually a history of repeated attacks, and but very slight or no enlargement of the inguinal glands.

Treatment.—Local treatment only is necessary, and consists in scrupulous cleanliness, protection of the sore from irritation, and the application of black-wash, zinc lotion, or iodoform. Should the glands become inflamed, rest in the recumbent posture is essential. If suppuration threatens, hot boracic fomentations must be applied, and a free incision, in a vertical direction, made as soon as pus has formed. The incision should not be parallel to Poupart's ligament since the movements of the groin would delay healing. Should any intractable sinuses, as frequently happens, be left after the bubo has suppurated, they should be laid freely open, and allowed to granulate from the bottom.

3. The *sloughing sore* is due to want of cleanliness or the retention of irritating discharges by a long foreskin, and generally occurs in weakly or debilitated subjects. The sore, which is covered with a yellow slough, and is surrounded by an angry areola of inflammation, spreads rapidly, and is attended with considerable swelling and œdema of the penis. The general appearances of the ulcer and its appropriate treatment have already been given in the section on *U lcers* (p. 34).

4. The *phagedœnic sore.*—Phagedæna may attack both the hard and soft sore, but is said by Mr. Hutchinson to be a more frequent complication of the former than of the latter. Like the sloughing sore, it may be due to want of cleanliness and neglect, or to the irritation of the discharges retained by a long foreskin. It seldom, however, occurs to any serious extent, except in those whose constitutions are broken down by want of food, abuse of alcohol,

debauchery, or exhausting disease. For a description of the characters and treatment of this ulcer see p. 34.

Epithelioma of the penis generally begins as a warty growth or as an ulcer on the glans or inner surface of the prepuce. Old age is looked upon as the chief predisposing, and the irritation of retained secretion under a long prepuce as the common exciting cause. The indurated, sinuous and everted edges of the ulcer, the warty base, sanious and foul discharge, rapid growth, advanced age of the patient, and later, the involvement of the inguinal glands, will generally serve to distinguish it from warts or venereal ulcers for which it may be mistaken. If allowed to run its course the whole penis becomes infiltrated with the growth; the lumbar, as well as the inguinal glands, become involved; sloughing and ulceration ensue, and the patient generally dies of exhaustion or hæmorrhage. The internal organs are not usually affected. *Treatment.*—If seen early, the growth alone may be removed. As a rule, however, the penis should be amputated in front of the scrotum unless the glands are much involved or the disease extends backwards beyond this point. In such a case the scrotum may, under certain conditions, be split, the whole penis, with the crura, removed, and the urethra stitched to the perineum. The inguinal glands if not too extensively diseased should be also removed.

Amputation of the penis is often performed by one swoop of the knife; when thus done the urethra is liable to retract and cause subsequent trouble in micturition. It is best therefore to divide the corpus spongiosum about half an inch further forward than the corpora cavernosa, and then split the urethra and secure it by four sutures to the skin. The skin should be drawn well forward before it is divided, as otherwise it is apt to obscure the more retractable stump, and render the securing of the arteries difficult. Too much skin moreover is liable to obstruct the orifice of the urethra. Hæmorrhage during the operation should be restrained by Clover's clamp or by the fingers of an assistant. The two dorsal arteries and the arteries of the corpora cavernosa and of the septum usually require ligature. Amputation by the galvanic écraseur is strongly advised by some, but is open to the objection that it may be followed by secondary hæmorrhage on the separation of the sloughs.

DISEASES OF THE SCROTUM, SPERMATIC CORD, AND TESTICLE.

Epithelioma of the scrotum, often called sweep's cancer from the frequency with which it occurs in chimney-sweepers owing to the irritation of the soot, generally begins as a dark wart or tubercle which ultimately ulcerates, producing a sore with hard sinuous everted edges, and an irregular warty tuberous base. In some instances ulceration is delayed and the cancer takes the form of a typical cauliflower-like growth. At times it begins as a chronic eczema. The irritant would appear to be not merely the carbon of the soot, but one or more of the products of the destructive distillation of coal, as the cancer does not occur from soot produced by the burning of wood, and is found amongst workers in coal-tar and its products. The inguinal glands become enlarged early, at first from inflammatory infiltration, later from invasion by the epithelial growth, but the disease does not, as a rule, affect internal organs. The testicle may occasionally become involved, when the lumbar glands will be, sooner or later, affected. Death is commonly due to the exhaustion produced by the ulceration in the inguinal glands, or hæmorrhage from the opening of a large blood-vessel in the groin. *Treatment.*—Free and early excision with the knife, and removal of the inguinal glands if enlarged and hard. If the testicle is involved it should be excised at the same time. The skin of the part is very lax, and although the testicle may be denuded it, as a rule, rapidly becomes covered in. If there is not sufficient skin the testicle must be removed. When a deep dissection is necessary for the removal of the disease, a staff should be placed in the urethra to avoid injuring that canal.

Œdema of the scrotum, owing to the laxity of the tissues, is common. It may occur in kidney and heart disease as part of the general dropsy, or it may be caused by inflammation of the neighbouring parts, as the testicle. It is also met with in extravasation of urine, and may occur after an operation for hernia, varicocele, &c.

Erysipelas of the scrotum may be the result of slight injuries, abrasions, &c., or may occur idiopathically. It is attended with great swelling, redness and œdema, and is very liable to terminate in extensive sloughing and gangrene. The same general and local treatment should be adopted as described under *Erysipelas*, with free and early incisions should suppuration threaten.

Eczema and prurigo of the scrotum require no special mention.

Elephantiasis scroti is an enormously hypertrophied condition of the skin and connective tissue of the scrotum, and probably depends (like a somewhat similar condition known as *lymph-scrotum*, in which a milky fluid exudes from the skin) on the presence in the blood of the *filaria sanguinis hominis*. The lymphatics are blocked by the ova of the nematode, and stasis of the lymph stream ensues. The disease is common in the East, and in the West Indies, but is seldom met with in this country, and then hardly ever except in those who have lived in those parts. The penis is sometimes affected in a similar manner. *Treatment.*—The hypertrophied mass may be dissected off the testicle and penis, after elevating it for some hours before the operation in order to drain it as much as possible of blood. The base of the mass during the operation should be constricted by an elastic band.

Hydrocele is a collection of serous fluid in connection with the testicle or spermatic cord.

I. Hydroceles in relation with the testis.

A. *The fluid is contained within the tunica vaginalis.* Of this form there are four varieties. (1) *The common or vaginal hydrocele* in which the normal tunica vaginalis is simply distended with serous fluid. This form may be either acute or chronic. (2) The *congenital hydrocele* in which the fluid is contained in an unobliterated funicular process of the tunica vaginalis communicating with the general peritoneal cavity. (3) The *infantile hydrocele* in which the tunica vaginalis proper and part of the funicular process is distended with fluid as far as the external abdominal ring, the funicular process in the inguinal canal having been obliterated. Of this form there is a sub-variety, the *hydrocele en bissac* in which the funicular process has been obliterated at the internal abdominal ring and is contracted at the external ring so that there are two sacs continuous with each other by a narrow neck. (4) The *inguinal hydrocele* in which the tunica vaginalis is distended with fluid around the testicle retained in the inguinal canal. The sac generally communicates with the peritoneal cavity.

B. *The fluid is not contained in the tunica vaginalis.* Of this form there are two varieties: (1) *The encysted hydrocele of the epididymis* in which the fluid is contained in a sac connected with the epididymis. (2) *The encysted hydrocele of the testis* in which the fluid is contained in a space between the tunica albuginea and the tunica adnata.

II. Hydroceles in relation with the spermatic cord. Two varieties are described: (1) *Diffuse hydrocele of the cord,* which is nothing more than a localized œdema of the connective tissue of the cord. (2) *Encysted hydrocele of the cord* in which there is a distinct sac containing fluid and arising either (*a*) in connection with an unobliterated portion of the funicular process of the tunica vaginalis, or (*b*) in connection with some persistent remains of the urinary portion of the Wolffian body, viz., the paradidymis of Waldeyer or organ of Giraldès.

Common or vaginal hydrocele is a collection of serous fluid in the cavity of the tunica vaginalis.

Causes.—Infancy, middle age, heredity, gout, and malaria are said to predispose to it; whilst slight injuries, repeated strains, the presence of loose bodies in the tunica vaginalis, and certain chronic diseases of the testicle are sometimes exciting causes. Often, however, no apparently efficient cause whatever can be discovered. A collection of fluid in the tunica vaginalis is common in connection with gonorrhœal epididymitis, a contusion of the scrotum or punctured wound of the tunica vaginalis, and is then spoken of as acute vaginal hydrocele. It usually subsides in a few days with the disease or injury to which it is secondary.

Pathology.—By some it is looked upon as a passive dropsy, due to a loss of balance between the secreting and absorbing power of the tunica vaginalis; by others it is believed to be due to chronic inflammation. The fluid is of a pale straw colour, with a specific gravity of 1,020 to 1,030, and contains a large quantity of albumen. The dilated tunica vaginalis is usually thin; but in long standing cases it is occasionally greatly thickened, and may be of cartilaginous consistency. The coverings are the same as those of the testicle, viz., skin, superficial fascia, dartos, and intercolumnar, cremasteric and infundibuliform fasciæ.

Symptoms.—Ordinary hydrocele forms a smooth, tense, elastic or fluctuating swelling in the scrotum, of a pyriform, globular or oval shape, and is frequently slightly constricted at its middle or at its lower or upper part. The chief diagnostic sign is its translucency. If the walls are very thick it may appear opaque when examined for translucency in the usual way by the light of a candle; but I have never met with a hydrocele, however thick its walls, which was not found translucent when a powerful light, as that of an ophthalmoscopic lamp, was used. The cord is free, and there is no impulse on coughing, signs which serve to distinguish it from a hernia. When the hydrocele extends up the funicular portion of the tunica vaginalis into the inguinal canal there may however be a transmitted impulse from the abdominal wall; it might then be mistaken for an irreducible hernia. The dulness on percussion, the history that it began at the bottom of the scrotum, and the translucency, if the light be powerful enough, will distinguish it. The translucency must not be relied upon entirely, since a hernia in an infant containing only empty intestine is translucent, and if strangulated, would, like a hydrocele, be irreducible, and give no impulse on crying. An hydatid cyst in the tunica vaginalis would also be translucent. The testicle is situated behind and near the lower part of the hydrocele, save in exceptional cases where adhesions have been contracted to the anterior wall, or the testicle has descended retroverted.

The *treatment* may be palliative or radical. *Palliative treatment* consists in tapping the hydrocele with a trocar and cannula, and repeating the operation from time to time as required. Before tapping a hydrocele the situation of the testicle should be made out, lest it be injured by the trocar. This can usually be done by marking the opaque spot whilst examining for translucency, and by the patient's sensation on handling it. If the sac is not very tense the testicle can be felt. Choose a spot for puncture near the bottom of the swelling, free from scrotal veins, which can readily be seen through the skin, and having made out the situation of the testicle, grasp the tumour from behind with the palm of the hand so as to make it tense, and plunge the trocar and cannula, held as in Fig. 385, sharply into the sac to ensure perforating the wall. The trocar should be directed at first backwards, and then immediately turned upwards to avoid wounding the testicle. Having withdrawn the fluid, remove the cannula, and apply a small pad of lint or strapping.

The *radical cure* is commonly effected by injecting tincture of iodine into the sac through the cannula after having withdrawn the fluid. The quantity injected is usually about two drachms. If ten drops of a 5 per cent. solution of cocaine are injected before the iodine no pain generally is felt at first, but as the effect of the cocaine wears off, intense pain, lasting for an hour or more, is often experienced.

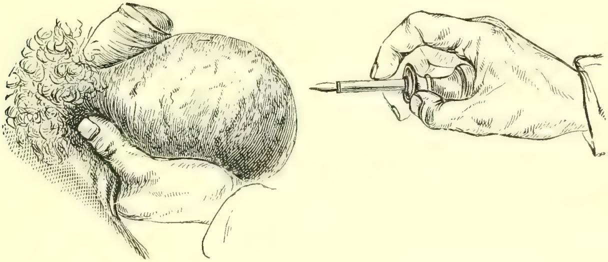

Fig. 385.—Tapping a hydrocele. (Bryant's Surgery.)

Injections of carbolic acid (1 in 20), or of perchloride of mercury (1 in 2,000) appear to be equally effective, and are attended with little or no pain. The injection sets up some slight amount of inflammation, and generally cures by restoring the balance between the secreting and absorbing power of the tunica vaginalis, or occasionally by causing adhesions between the two layers of the tunica vaginalis. Should the injection fail, it may be repeated; or the tunica vaginalis may be laid open, a portion cut away, and the remainder united by suture and drained. But even this treatment cannot always be depended on for curing the hydrocele. The only absolutely certain method is to lay open the sac and allow it to granulate up from the bottom.

The hydroceles so frequently seen in young children generally undergo a spontaneous cure, and nothing beyond a discutient lotion is usually necessary. Should the hydrocele prove intractable, however, it may be punctured with a fine trocar and cannula, and, if necessary, afterwards injected with a weak solution of iodine, CONGENITAL HYDROCELE is a collection of fluid in the sac of the tunica vaginalis, the funicular process of which through an arrest of development has remained unobliterated. The fluid, therefore, unless the aperture of communication is very small, can be readily pressed back into the abdominal cavity, and an expansile impulse is given to it on coughing or crying. In this respect it resembles a congenital hernia, as it does also by coming on slowly shortly after birth, and by occupying the inguinal canal, as well as the scrotum; but its translucency, dulness to percussion, regularity of outline, uniform feel, and the fact that the fluid goes back slowly when pressed upon, and without the sudden slip or gurgle as is the case in a hernia, should serve to distinguish it. It should not be forgotten that a piece of omentum or intestine may descend into the sac of the hydrocele. At times, the aperture of communication between the funicular process and the general peritoneal cavity is closed, and though the hydrocele may still extend more or less up the inguinal canal, the fluid cannot be pressed back into the abdominal cavity. To this condition the name of *infantile hydrocele* has been given.

Treatment.—A truss should be applied over the inguinal canal to cause obliteration of the funicular portion of the tunica vaginalis, and to prevent the descent of a hernia, and subsequently the hydrocele may be treated in the ordinary way. Should this not suffice, the funicular process may be exposed by open incision, the neck ligatured, and the sac removed. As a rule, however, when the obliteration of the funicular portion has been accomplished, the hydrocele undergoes a spontaneous cure.

ENCYSTED HYDROCELE OF THE TESTICLE AND EPIDIDYMIS.—This term is applied to a cyst or cysts formed in connection with the testicle or epididymis, but having no communication with the cavity of the tunica vaginalis. Cysts in connection with the testicle itself are very rare. They are formed by the collection of fluid between the tunica albuginea and tunica adnata, and require no further description here. Encysted hydroceles of the epididymis, however, though still rare, are more often met with, and may be divided into (1) the *subserous cysts*, which are of no clinical importance, except that they may sometimes become pedunculated, and then getting detached may form loose bodies in the tunica vaginalis, and (2) the *parenchymatous* or *spermatic cysts*. The latter are thin-walled, membraneous cysts lined with tesselated epithelium, and containing a watery, slightly opalescent or milky fluid, in which there is often an abundance of spermatozoa. The presence of the spermatozoa may be due to the rupture into the cyst of one of the seminal ducts; or to the cyst being developed in connection with a seminal duct. The origin of these cysts is doubtful. They are generally believed, however, to be developed from some of the fœtal remains of the

Wolffian body or Müllerian duct, such as the organ of Giraldès, hydatid of Morgagni, &c., so abundant in the situation of the epididymis.

Signs.—They appear as tense, fluctuating, translucent, moveable, globular, smooth or lobulated swellings, without impulse on cough, and situated immediately above or behind the testicle. The cord is generally free. They are often combined with an ordinary hydrocele.

Treatment.—These cysts usually give rise to no inconvenience, but should they increase in size and cause pain, they may be tapped in the ordinary way, or, if this fails, dissected out with strict antiseptic precautions. Injection has not been attended with success.

ENCYSTED HYDROCELE OF THE SPERMATIC CORD is a collection of serous fluid in an unobliterated portion of the funicular process of the tunica vaginalis. The fluid is similar to that of an ordinary hydrocele. The coverings of the cyst are those of the funicular process, viz., the skin, and the superficial, intercolumnar, cremasteric, and infundibuliform fasciæ; the vas with the arteries and veins are behind it.

Signs.—An encysted hydrocele of the cord appears as a well-defined, tense, oval or globular, fluctuating, freely moveable swelling in the course of the spermatic cord. It is unconnected with the testicle below, and cannot be reduced into the abdomen above although it may be pushed back some distance up the inguinal canal. It is translucent, and gives no impulse on coughing. But when high up in the inguinal canal, it may be difficult to distinguish from a small irreducible hernia, as an impulse is communicated to it from the abdominal walls, and it may be impracticable to detect its translucency. A cautious puncture with an exploring needle may then be necessary to diagnose it.

Treatment.—Painting with tincture of iodine may first be tried. This failing, the cyst should be punctured with a small trocar and cannula. Should it refill, it may be injected with iodine, &c., like an ordinary hydrocele, or it may be laid open by an antiseptic incision; or better, dissected out, and if it communicates with the peritoneal cavity, a fact which may be determined by passing an aseptic probe along its neck, the neck should be freed and ligatured as high up as possible. Before undertaking its radical cure by injection, it must be ascertained that there is no communication with the peritoneum. This may usually be done by noting that no decrease in size takes place on applying steady pressure for some little time.

A HYDROCELE OF A HERNIA SAC is said to result when the sac of a pre-existing hernia has become distended with fluid after the contents of the sac have been reduced and its neck has from some cause, as an adherent piece of omentum, become obliterated. *Signs.*—

The swelling is elastic, fluctuant, and, perhaps, translucent. There is no impulse on coughing, but a history of a former hernia in the situation in which the swelling has formed. *Treatment.*—It should be cut down upon, the neck ligatured, and the sac itself dissected away.

VARICOCELE is a dilated and varicose condition of the spermatic plexus of veins (Fig. 386).

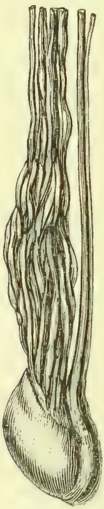

FIG. 386.—Varicocele. (St. Bartholomew's Hospital Museum.)

The *causes* of varicocele are not really known. It has been attributed to an extra lax state of the parts, induced by debility and general want of tone; congestion from too early or continual excitement of the sexual organs; occupations involving long standing; and to certain anatomical peculiarities (all of which, however, are present in every healthy male), such as the great length of the spermatic veins, the dependent position of the testicle, the plexiform arrangement of the veins in the scrotum, &c. But it often occurs in men in good health, and in whom the parts are not lax. The reasons given for its much greater frequency on the left than on the right side are—1, that the left vein is longer than the right; 2, that an obstacle is offered to the outlet of the left vein by its opening at right angles into the renal vein; 3, that the blood pressure is less in the vena cava than in the renal vein; 4, that the left vein is crossed by the sigmoid flexure, and is hence liable to be pressed upon by fæcal accumulations. Mr. Bennett considers that it is due to congenital malformation in the spermatic venous apparatus. Mr. W. G. Spencer, who has recently worked at this subject, believes that the presence of the large veins is due to a congenital variation from the normal process of development, whereby many of the veins of the Wolffian body (from which the spermatic veins are formed) remain unobliterated and capable of being dilated by anything obstructing the return of venous blood from the testicle. More of these veins, he says, are normally obliterated on the right than on the left side.

Symptoms and diagnosis.—There may be merely a sense of weight and fulness in the scrotum, or dragging, or even severe, pain, worse after the day's work but relieved by recumbency. The symptoms, however, are often more mental than physical, the patient fearing impotence or sterility, and sometimes becoming hypochondriacal in consequence. The varicose veins, which may sometimes be seen through the skin of the scrotum, form a soft, irregular, opaque, knotted, pyriform mass, in which there is a distinct expansile thrill or impulse on cough. The swelling is confined to the scrotum, and although it may be reduced on the patient's lying down, it does not go back with a gurgle or slip like a hernia, and gradually returns when the patient rises, notwithstanding that the finger is placed over the external abdominal ring. The testicle, though perhaps, as a rule, a little smaller than natural, is seldom much atrophied. The *treatment* may be either palliative or radical.

The *palliative treatment* consists in cold sponging, the use of shower-baths, healthy exercise, regulation of the bowels, and the administration, when indicated, of ferruginous tonics; whilst the mental anxiety of the patient should be relieved by the assurance that atrophy or impotence need not be feared. *Locally*, a suspensory bandage should be worn, or the veins braced up by drawing the lower part of the scrotum through a *Wormald's ring*.

The *radical treatment* should be undertaken (1) when the varicocele is large or causes much pain; (2) when it acts as a bar to entering the public services; or (3) when it appears to be inducing atrophy of the testicle. Whether it should or should not be undertaken for the cure of mental distress, must be left to the judgment of the surgeon in each individual case. The operations for the radical cure, which have for their object the obliteration of the enlarged veins, are many. The one I prefer is the subcutaneous ligature; but the ligature of the veins by open incision is an excellent operation, provided strict antiseptic precautions are taken. If the open method is chosen, the incision should be made over the inguinal canal rather than in the scrotum, since it is most difficult to thoroughly disinfect the skin in the latter situation. *The subcutaneous method* may be done as follows:—Separate the vas, which can always be felt as a rounded cord, from the veins; pass with a nævus-needle a thread of fine silk or kangaroo-tail tendon between the veins and the vas, and then back again between the veins and the skin, and tie the veins, allowing the knot to slip through the puncture in the skin. Repeat the procedure three quarters of an inch above, and place the scrotum in an antiseptic dressing. The spermatic arteries escape injury as they slip away with the vas, to which they are attached. This method can be recommended as safe, painless, efficient, easy of performance, and as necessitating the minimum amount of rest subsequent to its performance. A hard mass remains for some months between the situations of the ligatures, but gradually disappears in time. Where the veins are much elongated, the open incision is, perhaps, the best, since a portion can then be excised, and the two ends tied together, thus shortening the cord and bracing up the testicle.

Tumours of the spermatic cord are occasionally met with; lipomata only are here described. *Lipomata* are not very uncommon. They occur as elongated, soft, semi-fluctuant, smooth, or occasionally finely lobulated swellings. They spring from the subperitoneal fat, and during their descent along the inguinal canal may draw down a process of peritoneum, into which a hernia may descend. They are more often met with on the left side, occur in lean as well as in fat people, and increase slowly and steadily in size. They may be distinguished from an inguinal hernia, with which they are often associated, by being irreducible, by having as a rule no impulse on cough, by their elastic feel and by descending lower when traction is made on the testicle. *Treatment.*—Open incision and dissecting out the growth.

TORSION OF THE SPERMATIC CORD, *i.e.*, a twisting of the cord so that the epididymis is felt in front instead of behind the body of the testis, is occasionally met with either in a testis to all external appearance previously normal, or in a testis retained in the inguinal canal. The twisting has been attributed to spasm of the cremaster. If unrelieved the testicle will atrophy or necrose.

Symptoms.—The torsion is attended by a tender and painful swelling in the groin or scrotum, dull to percussion, irreducible, and without impulse on cough, the symptoms generally coming on suddenly after great strain or exertion. Vomiting is nearly always present, and there may be constipation. Thus when the testis is retained a strangulated hernia is very closely simulated.

Treatment.—When seen early the cord may be readily untwisted if the testis is in the scrotum, the symptoms at once disappearing as in Nash's case. If the testis is in the groin or inguinal canal, it should be removed and the canal and ring closed by sutures.

HÆMATOCELE or COMMON HÆMATOCELE is an effusion of blood into the cavity of the tunica vaginalis. Blood may also be effused into an encysted hydrocele of the testis, epididymis or cord, into the substance of the testicle itself, or into the tissue of the scrotum; and to such the terms hæmatocele of the testis, hæmatocele of the cord &c., have been applied. All of these conditions, however, are too rare to admit of any description here.

Causes.—An ordinary hæmatocele may be due to a blow on the testicle, or a strain in lifting heavy weights, or a like injury to a hydrocele; to puncture of the testicle or a blood-vessel in tapping a hydrocele; or to the giving way of a weakened or varicose vessel in consequence of the alteration in tension on removal of the hydrocele-fluid by tapping. At times, however, it may occur spontaneously, and is then probably due to some atheromatous or other change in the vessels, or chronic inflammation of the tunica vaginalis.

Pathology.—The effused blood may be absorbed, or it may clot and be deposited on the walls of the sac, giving the hæmatocele on section the appearance of an aneurysm (Fig. 387); or the central portions of the clot may break down into a chocolate-coloured fluid, which under the microscope is seen to consist of disintegrating blood-corpuscles and hæmatin and cholesterin crystals. At times suppuration may take place, the fluid in the sac then consisting of a mixture of broken-down blood and pus. Calcification of the walls in old-standing cases may occur.

Signs and diagnosis.—Hæmatocele comes on suddenly, appearing as a smooth, tense or semi-fluctuating, oval or globular, non-translucent swelling in the scrotum. At first there may be considerable pain in the testicle and ecchymosis of the scrotum; but later, neither, as a rule, will be present. Testicular sensation is generally discovered behind the swelling. The freedom of the cord and absence of impulse on coughing should at once serve to diagnose it from a hernia, and its non-translucency from a hydrocele. But from malignant or other growths it is often difficult to distinguish it; and, indeed, in some cases it is only after puncture with a grooved needle or even after an exploratory incision, that this can be done. The history of its sudden onset, its shape, the absence of the varying consistency noted in malignant disease, the non-involvement of the glands or of the cord, and the presence of testicular sensation posteriorly, should help in the diagnosis. On puncture a chocolate-coloured fluid escapes in the one case; arterial blood or nothing at all, in the other.

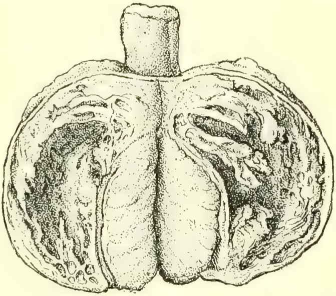
Fig. 387.—Hæmatocele. (St. Bartholomew's Hospital Museum.)

Treatment.—When the hæmatocele is recent, rest in bed, the application of cold or of evaporating lotions, and the elevation of the part on a pillow, may lead to the absorption of the blood. If this fails, the blood may be withdrawn with a trocar and cannula. When such is done, however, the sac in my experience generally refills, and I believe time is gained in the end by at once making a free incision into the sac, turning out the clots, securing any bleeding vessel that may be seen, and allowing the wound to heal by granulations. In long-standing cases, and especially when the walls are much thickened, this treatment is clearly indicated, but if, on laying the sac open, the walls are found of cartilaginous consistency, perhaps calcified, and the patient is old or broken down in constitution, excision of the testicle is then called for, as otherwise long-continued suppuration, which may terminate in exhaustion and death, may ensue. Where suppuration has occurred, a free incision should, under any circumstances, at once be made.

ACUTE INFLAMMATION OF THE TESTICLE is generally spoken of as *orchitis*, or as *epididymitis* according as the body or the epididymis is primarily or chiefly affected.

Causes.—Gonorrhœa is the most frequent cause; but injury of the testicle, or irritation of the prostatic urethra, as from the tying in of a catheter, or from the impaction of a calculus or fragment of a calculus, are not uncommon causes. Orchitis sometimes occurs during an attack of mumps, and is then said to be due to metastasis. It also occurs in gout, occasionally in rheumatism and malaria. It has also been attributed to the use of strong injections for the cure of gonorrhœa. How inflammation of the testicle is induced by the irritation of the urethra is a disputed question. It is variously taught, however, that it is due to—1, inflammation spreading along the vas, the most likely view; 2, reflex irritation; and 3, metastasis.

Pathology.—The walls of the tubules and the intertubular connective tissue become infiltrated with inflammatory products, and the tubules filled with desquamated epithelium. Resolution usually occurs, leaving the testicle little or not at all impaired either in structure or function. Suppuration, however, is occasionally induced; and when the epididymis is chiefly involved, the inflammatory material, in place of being absorbed, may be converted into fibrous tissue, which, subsequently contracting, may cause obstruction of the tubules of the epididymis. Such may be known to have occurred by the presence of a small hard lump in the region of the globus minor or major. An effusion of fluid into the tunica vaginalis (*acute hydrocele*) is very common, but more so in epididymitis than in orchitis, because the visceral layer of the tunica vaginalis is in contact with the inflamed tissue in the former case, but is separated from it by the thick tunica albuginea in the latter.

Signs.—In a well-marked case there is intense pain in the testicle, with a dragging or aching pain in the groin and along the course of the cord. The testicle is swollen, and exquisitely tender on handling; the vas feels uniformily swollen and thickened; and the skin of the scrotum is œdematous and of a dusky-red colour. When the inflammation falls on the epididymis, the pain and swelling will be chiefly confined to the lower and back part of the testicle—the region of the tail of the epididymis, *i.e.*, the globus minor—and fluid will often be detected in the tunica vaginalis. The discharge, if the inflammation of the testicle occurs during an attack of gonorrhœa, generally ceases or becomes less when the inflammation is at its height. The local signs are often accompanied by sharp febrile disturbance, raised temperature, furred tongue, nausea or even vomiting, and constipation.

Treatment.—When the attack is acute, rest in bed with the testicle supported on a pillow is desirable. Hot fomentations, and, in the intervals, hot boracic poultices applied to the testicle and groin, give the most relief. Internally a brisk purge should be given at the onset, followed by saline laxatives and small doses of antimony. If the pain is very severe, opium or salicylate of soda (grs. xx. every hour or two) may be given; or belladonna and glycerine may be applied; or a vein of the scrotum opened; or the tunica vaginalis or testicle punctured to relieve tension either with a needle in several places or with a tenotomy knife. If suppuration occurs, a free incision should be made to let out the pus. In subacute attacks, where the patient is unable to leave his work, a suspensory bandage should be worn. If the testicle remains enlarged it should be strapped. Appropriate remedies must be given should the inflammation have a gouty, rheumatic or malarious origin.

CHRONIC INFLAMMATION of the testicle may be a sequel to the acute disease; or it may begin as a chronic or subacute affection, and, like the acute form, may involve either the body of the testicle or the epididymis, or both. The two chief causes of chronic inflammation are undoubtedly syphilis and tubercle; but it may occur quite independently of either of these affections, and should then, for the sake of distinction, be called *simple chronic orchitis* or *epididymitis.* The *syphilitic* and *tuberculous* forms are described separately under those heads.

Signs.—The testicle appears enlarged, smooth, laterally compressed, egg-shaped, hard, heavy, and painful on pressure; the testicular sensation is not lost; the vas is but slightly thickened; the skin is non-adherent, and the epididymis (except when the disease is limited to that part) is not distinguishable from the body of the organ. In *chronic epididymitis* an indurated, painful, and tender lump is felt in the situation of the globus minor or major.

Treatment.—Mercury or iodide of potassium should be given internally, and strapping applied to the enlarged organ when the body is chiefly affected. In chronic epididymitis, in addition to internal remedies, inunction with mercurial ointment may be of service.

TUBERCULOUS DISEASE OF THE TESTIS may result from (1) primary infection, *i.e.*, the tubercle bacillus having entered the blood stream from without, may find its locus minoris resistentiæ in the testicle, or (2) it may be secondary to similar disease existing in neighbouring organs, such as the bladder, prostate, &c., and is then due to extension of the disease along the vas deferens.

Pathology.—The disease generally begins in the epididymis, and thence may spread to the body of the organ. It may also, when it primarily attacks the testis, extend up the vas to the vesiculæ seminales and prostate, and thence to the bladder, and even to the ureters and kidneys. In some cases the testicle appears to be the starting-point of a general tuberculosis; in others, merely to be involved in common with other organs in the general disease. In many instances, however, the disease may remain localized to the testicle, and no other manifestation of tubercle occur in the body. The inflammatory products infiltrating the epididymis and testicle have a great tendency to undergo caseation, forming the non-vascular yellow masses of cheesy-looking material so characteristic of the disease (Fig. 388).

Signs.—The disease usually begins very insidiously and with little pain. The epididymis, especially the head, and later the body of the testicle, are found enlarged. The testicle is usually but slightly tender on handling, and the testicular sensation is not lost; a hydrocele may be present, or part of the tunica vaginalis may be obliterated. Subsequently the cord, especially the vas, becomes thickened and the skin adherent; whilst still later, the skin may give way and a fungus composed of the infiltrated tubules protrude, or a discharging sinus be produced. The vesiculæ seminales or prostate may now be felt enlarged on examining by the rectum, and bladder or urinary troubles may set in; whilst symptoms of tubercle in the lung, larynx or other organs may supervene and the patient succumb to tuberculous disease. At other times no constitutional signs manifest themselves, and the patient may completely recover.

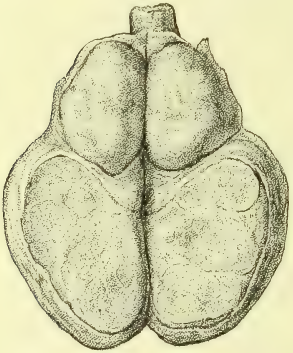

Fig. 388.—Tubercle of the testicle. (St. Bartholomew's Hospital Museum.)

Diagnosis.—From *syphilitic orchitis* it may generally be distinguished by the enlargement of the epididymis, the moniliform thickening of the cord, non-absence of testicular sensation, adhesion of the skin, tendency to softening and suppuration, enlargement of the vesiculæ seminales, concomitant signs of tubercle elsewhere, non-effect of anti-syphilitic remedies and the discovery of tubercle bacilli, should there be an open wound, by cultivation experiment of the discharge. From *malignant* disease it may, as a rule, be readily diagnosed, in that the malignant affection is of rapid growth, very painful, and affects the whole organ without destruction of body or epididymis.

Treatment.—In the early stages, before the vas or vesiculæ seminales have become involved, some surgeons advise the removal of the organ for the purpose of preventing, if possible, general dissemination of the disease, and where both testicles are affected, even the removal of both. Others, however, rely on constitutional treatment, and only advise the removal of the testicle should it become destroyed by the disease. If the vesiculæ seminales are found affected in the early stages, or signs of tubercle are discovered in other parts, the testicle should of course on no account be excised. The *constitutional treatment* is that already described under Tubercle (p. 48). The *local treatment* consists in suspension of the organ, avoidance of horse or other violent exercise, and recumbency during an exacerbation of the inflammation. Should the tubercle soften and suppuration occur, the abscess must be opened, thoroughly scraped with a Volkmann's spoon, and the wound plugged with iodoform gauze. If intractable sinuses remain, they should be also scraped. If a fungus forms it will frequently recede under rest in bed, cleanliness, and the application of a stimulating ointment or of iodoform. Should the testicle become completely disorganized it had better be excised.

SYPHILITIC DISEASE OF THE TESTICLE occurs during the late secondary and the tertiary stages of syphilis. *Pathology.*—The lesion in the earlier stages of syphilis usually takes the form of a small-cell-infiltration of the intertubular connective tissue (*syphilitic interstitial orchitis*); in the later stages, of distinct gummatous masses, resembling gummata in other situations (*gummatous orchitis*). The body of the testicle alone is usually affected, and though, in some instances, *syphilitic epididymitis* is met with, the cord and epididymis generally escape. In the secondary stage both testicles may be implicated, either simultaneously, or, as more often happens, one after the other, the disease here, as in other secondary affections, manifesting its tendency to be symmetrical. Under appropriate treatment the small-cell-infiltration may be completely absorbed, leaving the testicle apparently little, if at all, affected; or it may undergo fibroid changes, and the subsequent shrinking of the fibrous tissue produce more or less atrophy of the organ. But it seldom breaks down and suppurates as the gummatous form in patients with undermined constitutions is apt to do. In the tertiary affection one testicle only is, as a rule, involved, the asymmetrical character of tertiary syphilis being thus borne out. The gummatous masses may clear up under treatment, but where the constitution is impaired they are liable to break down and suppurate or a fungous protrusion, though rarely, may occur. The typical appearance of a gummatous testicle on section is seen in Fig. 389. The organ is occupied by large yellowish-white nodules of a tough, fibrous, non-vascular material; some of the gummata are distinct;

the remainder have coalesced into a mass which occupies the anterior part of the organ. A loose fibroid tissue, which is very vascular and of a pink colour in the original specimen, surrounds and separates the nodules.

Signs.—Syphilitic disease is very insidious and painless in its onset, the testicle often attaining some size before the patient's attention is directed to it. The testicle is enlarged, very hard, not tender on handling, and, as a rule, absolutely painless; the testicular sensation is completely lost; the skin is not involved, but appears natural, and is freely moveable over the swelling. The signs, however, vary somewhat according to the stage of syphilis at which the testicle is affected. Thus, in the secondary stages, the testicle is smooth, oval, and often laterally compressed; in the tertiary, nodular and irregular, and the tunica vaginalis frequently contains fluid (*vaginal hydrocele*). In the secondary, usually both testicles are affected; in the tertiary, often only one. In the tertiary, moreover, the gummata, in neglected cases, or where the constitution is undermined, may break down, the skin become involved in the inflammation and give way, and a sore having the characters of a tertiary syphilitic ulcer result. More rarely a fungus may protrude. The characters of the secondary and tertiary disease, however, often merge into each other. A syphilitic testicle may have to be diagnosed from simple orchitis and from tuberculous disease. The freedom of the cord and epididymis, the absence of all pain and tenderness on handling, the loss of testicular sensation, the hardness of the organ, the non-implication of the skin, the presence of a vaginal hydrocele, the history of syphilis, the fact that the patient has not had gonorrhœa or a previous attack of acute orchitis, nor received an injury to the testicle, and the absence of signs of tubercle in other organs, point to the disease being of a syphilitic origin. The presence of a vaginal hydrocele is not of much diagnostic value, since in my experience it is almost as common in tubercle as in syphilis. It must not be forgotten, however, that syphilis may occur in a tuberculous subject; and that the characters of the two affections may then be more or less combined.

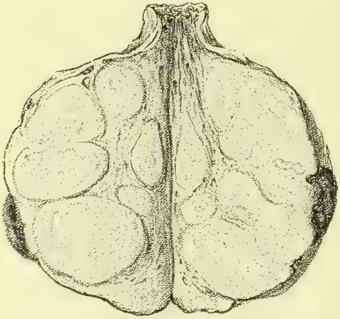

Fig. 389.—Syphilitic testicle. Gummatous variety. (St. Bartholomew's Hospital Museum.)

Treatment.—The earlier the testicle is affected in the course of constitutional syphilis, the more marked will be the effect of mercury; the later, of iodide of potassium. Often the best results are obtained from the two drugs combined. Locally, the testicle may be merely suspended; or it may be strapped in the earlier stages with advantage. Any fluid in the tunica vaginalis will commonly be absorbed during the treatment, though sometimes tapping may be required. Should the skin give way, and an ulcer be produced, it should be treated like other syphilitic ulcers. In rare instances, where the testicle is totally disorganized, extirpation may become necessary.

Chondromata or cartilaginous tumours of the testicle are very rare. A beautiful example, however, is shown in the accompanying illustration (Fig. 390). They may be known by their extreme hardness. They are thought to arise in connection with portions of the embryonic cells of the protovertebræ, carried down from the lumbar region with the testicle during its descent. Removal of the testicle is the proper treatment.

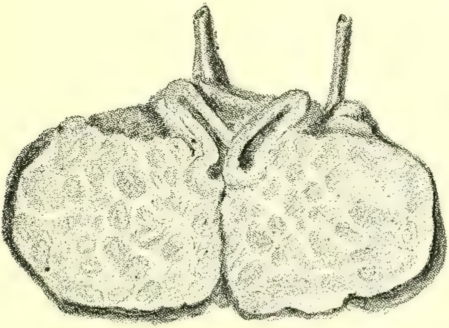

Fig. 390.—Chondroma of the testicle.
(St. Bartholomew's Hospital Museum.)

Cystic disease of the testicle embraces two distinct conditions, (*a*) one a simple, benign, cystic transformation of the testis, the *cysto-fibroma* or *simple cystoma*, and (*b*) a rapidly-growing malignant growth (the so-called *cysto-sarcoma*) in which besides its cystic nature there are sarcomatous elements. Both are probably varieties of the same disease, and differ chiefly in the structure of the inter-cystic stroma, which, in the simple cystoma, consists of simple fibrous elements, and in the malignant form of an embryonic connective tissue. They run widely different clinical courses, the one being benign, and not tending, as a rule, to recurrence after removal, the other growing rapidly and leading to dissemination in distant organs as well as recurrence *in situ* after removal.

Signs.—The *simple cystoma* grows slowly, and seldom attains a size larger than a turkey's egg. It is smooth on the surface, and is ovoid in shape. In consistence it varies according to the size of the cysts. The spermatic cord is not involved, and the lumbar glands are not enlarged. The disease usually occurs in middle life. The *cysto-sarcoma* grows rapidly, and in the space of a few months may attain the size of a cocoa-nut. The surface is usually uneven and the oval shape of the testis is speedily lost. The cysts, which are large and numerous, impart a sense of elasticity to the touch. The lumbar glands may be enlarged if the disease has existed long enough.

Treatment.—In both varieties the testicle should be removed as soon as the growth is recognized. Recurrence is very likely to take place in the malignant type, and sometimes even in the benign variety, but when this happens the intercystic connective tissue is usually found to be on the borderland of malignancy.

OTHER BENIGN TUMOURS of the testicle, such as fibroma, myxoma, myoma, and osteoma occur, but they are too rare to need description here.

MALIGNANT DISEASE OF THE TESTICLE generally occurs in the form of round-celled sarcoma, more rarely in the form of soft carcinoma; but, without a microscopical examination, the two diseases, even on section, are often quite indistinguishable. Sarcoma begins in the intertubular connective tissue, and most frequently occurs in early life; carcinoma in the tubules, as a proliferation of the epithelial lining, and is most common after the period of middle age. In both, the body of the organ is primarily affected, and all distinction between it and the epididymis is soon lost. Some effusion into the tunica vaginalis may at first occur; the two surfaces, however, rapidly become adherent, the skin is implicated, and a fungating mass protrudes externally. The lumbar glands are generally affected, the inguinal only becoming involved after the skin has been reached. In a typical case (Fig. 391) the growth appears, on section, like a mass of brain-matter, blotched in places with blood; whilst fibrous bands, the remains of the trabeculæ testis, are generally seen traversing the growth. Masses of cartilage are often found in the sarcomata, and cysts, sometimes containing intracystic growths, are not uncommon (*cystic sarcoma*). The disease formerly described as cystic sarcocele would generally appear to be of such a nature.

Signs.—The swelling is at first generally uniform, smooth, elastic, or tense and hard, and no distinction between the body and the epididymis can be made out; but later the cord becomes thickened and the lumbar glands enlarged, and the tumour may feel hard in one place and soft in another. Ultimately the skin becomes adherent, gives way, and a fungating mass, covered with a sanious discharge, protrudes.

Diagnosis.—The rapid growth, large size, and more or less globular shape of the tumour; the lancinating pain; the implication of the skin and lumbar glands; the enlargement of the scrotal veins; the protrusion of a bleeding fungus; and later, the constitutional cachexia, will indicate malignancy. In the early stages, however, a puncture or even an exploratory incision may be necessary to distinguish it from chronic orchitis, hæmatocele, and syphilitic orchitis. Thus, in malignant disease, arterial blood will generally flow; in hæmatocele, a chocolate-coloured fluid containing hæmatin crystals and broken-down blood corpuscles will escape; and in chronic orchitis, whether simple, syphilitic, or tuberculous, nothing beyond perhaps a drop or two of blood will be withdrawn by the cannula. At times a piece of the growth may come away in the end of the cannula, and a microscopical examination of this will further aid in the diagnosis.

Treatment.—Unless the glands are much affected, the cord is thickened, and great emaciation or cachexia is present, with signs of the disease in the internal organs, excision of the testicle should be performed. When this appears undesirable from the above-mentioned reasons, all that can be done is to give opium to relieve pain and tonics to keep up the general health, and to apply some disinfecting lotion to remove the fœtor attending the fungating mass. After removal of the testicle an early recurrence of the disease in the lymphatic glands or in the internal organs is only too probable.

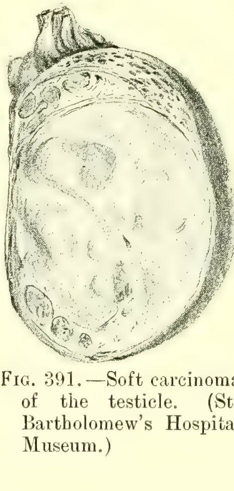

FIG. 391.—Soft carcinoma of the testicle. (St. Bartholomew's Hospital Museum.)

EXCISION OF THE TESTICLE.—The parts having been shaved, make an incision over the growth from the external abdominal ring to the bottom of the scrotum. Free the cord from its connections, and having clamped and divided it, enucleate the testicle with a few touches of the knife, taking care not to cut through the scrotal septum, and so remove the other testicle at the same time, a danger best avoided by giving the sound testicle into the charge of an assistant. Next tie the spermatic artery in the stump of the cord, and the cremasteric and deferential arteries, if seen; and having secured the cord by a Spencer Wells' forceps in order to prevent it slipping into the inguinal canal, loosen the clamp, and tie any other vessel that may then bleed before finally releasing it.

ATROPHY of the testicle may be simply the result of old age; or it may be due to—1, inflammation, especially that occurring during an attack of mumps; 2, interference with its blood supply as from the compression of the spermatic artery by a new growth or aneurysm; 3, obstruction to the venous return as in varicocele; 4, direct pressure on the organ, as by an old hæmatocele, or by the abdominal muscles or by a truss when the testicle is retained in the inguinal canal.

NEURALGIA of the testicle is occasionally met with, but pain in the testicle should not be pronounced neuralgic till the various diseases of the kidney, rectum, bladder and prostate, which may give rise to reflected pain in the testicle, have been excluded. When no cause for the pain can be discovered, the ordinary neuralgic remedies should be given, although the prospect of success from their use is not great.

RETAINED TESTICLE.—Non-descent of the testicle is said to be due to—1, the formation of adhesions in any part of its course into the scrotum; 2, disproportion between the size of the testicle and the abdominal rings; 3, paralysis of the gubernaculum testis; 4, too short a condition of the spermatic cord; and 5, malformation of the testicle. Thus the union between the vas deferens and the testicle, *i.e.*, the union of the Wolffian duct and the portion of blastema from which the body of the testicle is developed, may not occur, and the vas descends alone. The testicle may be arrested anywhere along its normal line of descent, *retained testis proper*, or it may depart from its normal route and be found located elsewhere than in its proper situation in the scrotum, *ectopia testis*. Of *retained testis proper* there are four chief varieties, viz., 1, abdominal retention in which the testis is located at or near its starting point in the lumbar region; 2, iliac retention in which it has become arrested in the iliac fossa; 3, inguinal retention in which it lies in relation to the inguinal canal, and of which there are three subvarieties; (*a*) *internal inguinal* when the testis is located at the internal abdominal ring; (*b*) *interstitial inguinal* when it lies in the canal itself, and (*c*) *external inguinal*, when its position is at the external abdominal ring; 4, *cruro-scrotal retention*, where the organ occupies the fold between the scrotum and the thigh. In these situations it is often associated with a congenital hernia. Of *ectopia testis*, there are two varieties, (*a*) *perineal ectopia*, in which the testicle is situated in the perineum immediately in front of the anus, and (*b*) *crural ectopia* in which the testicle leaves the abdominal cavity *viâ* the crural canal, and appears in the thigh just below Poupart's ligament.

Treatment.—In *abdominal and iliac retention* nothing can be done. In *external inguinal retention* the testicle should be coaxed into the scrotum by gentle and oft-repeated manipulations, and a truss with a <-shaped pad, the arms of the < embracing the testis, applied over the inguinal canal should there be signs of a hernia. If this truss does not keep up the hernia the testis had better be removed and the canal and ring closed by suture. In some instances the cord may be elongated sufficiently to allow the testis to be placed in the scrotum by detaching the globus minor from the body of the organ, and thus turning the testis upside down. The sac of the hernia may then be removed and the canal and ring closed. When the testicle is retained in the inguinal canal (*interstitial retention*), time should be given it to descend, and a truss applied, if possible, over the internal ring. Should it not descend as the child grows older, the question of its removal must be raised, as in this situation atrophy of the organ is nearly sure to ensue, and it is liable to be frequently attacked by inflammation, and to be affected by malignant disease. Moreover, it exposes the patient to the risks of hernia. In some cases, however, it may be returned into the abdomen, and kept there by a truss, or by closing the canal. In ectopia testis an attempt may be made to place the testis in the scrotum by a plastic operation, or, if this is impracticable, the testis should be removed.

SURGICAL DISEASES OF THE FEMALE GENITAL ORGANS.

DISEASES OF THE VULVA.

ADHESION OF THE LABIA MAJORA sometimes occurs as a congenital affection. The labia should be separated by forcibly drawing them asunder, with the assistance, if necessary, of a probe, and a piece of iodoform gauze placed between them to prevent re-adhesion. If neglected, it may be a source of inconvenience at puberty. The parts are then more firmly adherent, and may require division by the knife.

VULVITIS, or inflammation of the vulva, is in adults most usually the result of gonorrhœa, but occurs in young children, from other causes, such as cold, injury, the irritation of thread-worms, &c. Sometimes the sebaceous glands and hair-follicles of the labia are chiefly affected, the parts then appearing dotted over with small red pimples, and later, if suppuration occurs, with small pustules. There is usually much redness and œdema, and an offensive discharge. It is of some importance to recognise the fact that the disease may occur in children from simple causes, as, amongst the poor, mothers are apt to think their child has been tampered with. *Treatment.*—In addition to the removal of the cause, cleanliness, rest, attention to the general health, and the use of a mild astringent lotion, is all that is usually required.

ABSCESS occasionally follows inflammation of the vulva. It is often due to the extension of inflammation (generally gonorrhœal) to Bartholin's gland, or to suppuration in a labial cyst. A free and early incision should be made to prevent burrowing of pus, which is otherwise apt to occur, leading to the formation of obstinate fistulæ. Should these form they should be laid freely open.

CYSTS in the labium are generally due to the obstruction of a mucous follicle or the duct of Bartholin's gland, as the result of irritation. Dermoid and sebaceous cysts are more rarely met with. The mucous cysts generally contain a glairy fluid, and as their walls are thin, appear as semi-translucent, oval, elastic swellings. They occasionally suppurate. Excision of a portion of the wall, and cauterization, plugging, or scraping away the lining membrane to ensure healing from the bottom, is all that is usually necessary.

TUMOURS.—*Fibrous tumours* are occasionally met with in the labium. They are usually of the soft variety, and often contain myxomatous elements. They are frequently allowed to attain a large size. Removal is the only treatment. *Fatty tumours* and *nævi* are also met with; *sarcomata* but rarely.

Epithelioma is not uncommon, and may generally be distinguished from venereal warts and syphilitic, tuberculous or lupoid ulceration by the surrounding induration, the sinuous and everted edges of the ulcer, the history of the case, the age of the patient, and the early enlargement of the inguinal glands. Early and wide removal of the growth, together with any inguinal glands that may be felt enlarged, holds out the only prospect of success; but when the growth has attained any size, a rapid recurrence is but too frequent.

CONDYLOMATA AND VENEREAL WARTS are very common in this situation. They require no special description, and should be treated as described under *Venereal Diseases in the Male*.

PRURITUS may depend on various causes, as diabetes, eczema, ascarides, pediculi, &c. These should be sought, and, if possible, removed, the irritation being allayed in the meantime by such remedies as are mentioned under *Pruritus ani* (p. 673).

ELEPHANTIASIS OF THE LABIUM is rare. Like the similar condition of the scrotum, it may attain a large size. It may be removed by the knife, or better, as the hæmorrhage is free, by the galvano-cautery.

NOMA is an infective inflammation of the vulva, attended by phagedænic ulceration, and is not infrequently met with in the ill-fed, weakly children of the poor, especially after the exanthemata. Like cancrum oris, it probably depends upon the presence of a specific micro-organism. It begins as a dusky-red, indurated patch on one labium, with much swelling and œdema, and spreads rapidly, the central parts often becoming gangrenous. It is attended with severe constitutional disturbance, which soon assumes the typhoid type, and death from exhaustion or septicæmia frequently ensues. It may be followed by much cicatricial contraction, and even occlusion of the vulval orifice. The *treatment* should be energetic, The affected part should be scraped with a Volkmann's spoon, or destroyed by fuming nitric acid or the cautery, and an antiseptic dressing applied; whilst fluid nourishment, stimulants, and iron should be freely given, and opium cautiously administered in doses suitable to the age of the child. In milder cases the application of boro-glyceride may suffice. In very severe cases, the continuous warm bath has been found of great service.

DISEASES OF THE VAGINA.

Acute vaginitis (*colpitis*) is generally due to gonorrhœa, but may occur as the result of the use of strong injections, the introduction of foreign bodies, cold, and the exanthemata. It is attended with the signs of inflammation, and with a profuse, generally purulent, and sometimes blood-stained discharge. There is pain on urination and defæcation, and tenesmus. The inflammation may spread to the uterus, and thence to the Fallopian tubes, or to the urethra and Bartholin's glands. Saline purgatives, rest, warm hip-baths, abstinence from alcohol, and cleansing the part with Condy's lotion, followed by astringent injections, is the proper treatment.

Tumours of the vagina are rare, and require no special notice.

Cysts of the vagina are occasionally, though rarely, met with as the result of the distension of the mucous follicles; and others are described as originating from remnants of Gartner's duct, or from the dilatation of lymphatics. They should be dissected out.

Vesico-vaginal fistulæ, when not due to malignant disease, are generally the result of sloughing, consequent upon the pressure of the child's head in a prolonged or instrumental labour, though they may be occasionally produced in other ways, as from the impaction of a foreign body in the vagina or urethra, injury, &c. They give rise to incontinence of urine, and are productive of great inconvenience. They may be so small as merely to admit a probe, or nearly the whole of the anterior wall of the vagina may be destroyed. The common situation is just below the neck of the uterus. *Treatment.*—Where the fistula is very small, touching it with the actual cautery may succeed in closing it; but a plastic operation is usually necessary. The rectum having been cleared by an enema, the patient should be placed in the lithotomy position, and a duck-bill speculum introduced. The edges of the fistula should then be pared, and brought together with silver-wire or silk-worm gut suture. The sutures should be placed sufficiently close to prevent the passage of urine between them. A good way of testing if they are close enough, is to inject milk into the bladder, so that should any escape through the fistula, its colour will make it visible. Smith's needle will be found very convenient if wire sutures are used. The bladder should be emptied by a catheter at regular intervals; the vagina syringed out with an antiseptic solution, and dusted with powdered iodoform; and the bowels kept confined for a week or more.

RECTO-VAGINAL FISTULÆ may occur from causes similar to those leading to the vesico-vaginal variety; they are also sometimes congenital. They are commonly situated just within the entrance to the vagina, and may be closed in the same way as the vesico-vaginal fistula.

UTERO-VESICAL AND UTERO-RECTAL FISTULÆ may also occur, but are too rare to require any description here.

IMPERFORATE HYMEN, if overlooked till after puberty, is a serious affection, as the vagina, and later the uterus and Fallopian tubes, may become distended with the retained blood, conditions known respectively as *hæmato-kolpos*, *hæmato-metra* and *hæmato-salpinx*. If relief is not obtained, enormous distension may occur, and the tubes or uterus give way, setting up peritonitis. Or the hymen itself may yield, and all end well; or sapræmia may occur from putrefaction of the blood and absorption of the septic products on the admission of air; or septic peritonitis may be produced by the sudden alteration of pressure or the contraction of the uterus causing rupture of the tubes and escape of fluid into the peritoneum. *Treatment.*—Before puberty, division or excision of a portion of the hymen is a simple and safe operation; but when distension has occurred, it is attended with great risk, as if a free opening is made there is danger of peritonitis from the same causes as when spontaneous rupture takes place, and if a small opening is made, of sapræmia from decomposition. The safest plan, perhaps, is to make a moderate sized opening, wash out with perchloride of mercury lotion (1 in 5,000), and subsequently keep the parts cleansed by irrigation with antiseptics.

MALFORMATIONS OF THE VAGINA.—*Atresia* or *imperforate vagina.* The vagina may be completely absent, or divided by a transverse or horizontal septum. The uterus and ovaries may also be absent, and no trouble will then result; but when these are present, similar results to those described under imperforate hymen may follow. Atresia of the vagina may also be due to adhesions or the contraction of cicatrices following ulceration, &c. The absence of the uterus may be determined by introducing a catheter into the bladder, and the finger into the rectum, when the two will be felt to be in close apposition. In such a case no operation should be undertaken, as all that would be achieved would be to open the peritoneal cavity. Where the uterus and ovaries are present, and distension has occurred, if the vagina is only partially absent an attempt may be made to form a vagina by dissecting carefully through the tissues between the bladder and the rectum in the direction of the os. When this is found, the parts must then be prevented from re-adhering by introducing laminaria tents, frequent digital examinations, &c. Where the vagina is completely absent the uterus may become distended, and may then either be punctured through the rectum, or in some instances together with the ovaries be removed.

CYSTOCELE AND RECTOCELE are the names given to a prolapse of the anterior and posterior wall of the vagina respectively. In the former the bladder of course protrudes; in the latter the rectum or the pouch of Douglas which may contain some small intestine. Partial prolapse of either wall is a frequent accompaniment of extensive ruptures of the perineum. These affections generally fall under the care of the obstetrician, but at times the surgeon may be called upon to perform a plastic operation for their cure. This consists in removing a portion of mucous membrane from the upper or lower wall of the vagina as the case may be, bringing the raw surfaces together with sutures, and keeping the bladder empty with a catheter till firm union has taken place.

DISEASES OF THE OVARIES AND FALLOPIAN TUBES.

OVARIAN TUMOURS.—Ovarian tumours may grow either from the ovary itself, or from the broad ligament, and may be either solid or cystic. Amongst the solid tumours, which are rare, carcinoma and sarcoma are the most common. Amongst the cystic the so-called multilocular cysts are most frequently met with; but other forms, as the unilocular, the dermoid, and the parovarian cysts, may also occur. For a description of these tumours and of their pathology, which, at the best, is but imperfectly understood, the reader is referred to a special work on the subject.

Symptoms.—There may be no symptoms at first; but as the tumour increases in size, it gradually encroaches on the space normally allotted to the pelvic and abdominal viscera, giving rise to one or more of the following symptoms. Thus, from pressure on the bladder and rectum there may be increased micturition and constipation; from pressure on the iliac vessels, œdema of the lower limbs and genitals; from pressure on the sacral and lumbar plexus, pains in the back, pudenda, and legs; from pressure on the stomach, nausea and vomiting; on the intestines, diarrhœa or colicky pains; on the portal vein, ascites and hæmorrhoids; on the kidneys and ureters, albuminous and highly-concentrated urine, rich in urates. Later, as the tumour extends upwards, there will be embarrassed breathing and dyspnœa from pressure on the heart and lungs; while finally emaciation sets in, and the patient dies of exhaustion, if not carried off by an intercurrent attack of peritonitis from rupture of the cyst.

The physical signs vary according to the size of the cyst, and the diagnosis at first may be attended with some difficulty. But as the cyst rises out of the pelvis, and the abdomen becomes gradually distended, the condition known as ovarian dropsy is produced, the physical signs of which somewhat resemble dropsy of the peritoneum (*ascites*) depending on visceral disease. In *ovarian dropsy* the abdomen is dull in front, resonant in the flanks; the dulness is not altered by position; and the distension is greatest in the hypogastric and umbilical regions. Whereas in *ascites* the abdomen is resonant in front, dull in the flanks; the dulness is altered by position, the dull flank becoming resonant when the patient is placed on the opposite side; the distension is most marked laterally; and the circumference is greatest at the level of the umbilicus. In both a percussion wave or thrill generally exists, but in ovarian disease it is usually limited to the dull area, whilst in ascites it is as a rule felt all over. In ascites, moreover, there is probably other evidence of the visceral disease which is producing the dropsy; and if the abdomen is punctured the fluid will be found to be of a thin and serous character. In ovarian disease the uterus is usually displaced. An ovarian tumour may also have to be distinguished from pregnancy, tympanites, encysted dropsy of the peritoneum, tumours of the omentum, subperitoneal cysts and tumours, fibroids of the uterus, pelvic hæmatocele and abscess, extra-uterine pregnancy, and a distended bladder; but the differential diagnosis cannot be attempted in a work of this character. Having, however, determined that the disease is an ovarian cyst, the next point to make out is whether it is unilocular or multilocular; free or adherent. The *multilocular* cyst is usually irregular; fluctuation is absent, or more marked in some parts than in others; and there is no thrill or fluctuation wave on percussion, unless one of the cysts has attained a preponderating size. The *unilocular* cyst is smooth, rounded, regular, and elastic; fluctuation is felt equally distributed over the whole of the dull area. If *adhesions are present* the cyst is fixed, unless they take the form of elongated bands, in which case a friction rub or sound may be felt or heard. The umbilicus moves with the cyst; but no movement is detected on examination by the rectum or vagina. If *there are no adhesions* the cyst moves on respiration, but the umbilicus does not move with the cyst, and the cyst is not found fixed on examination by the rectum or vagina. Such are the chief points to be attended to; but often the signs are delusive, and where a tumour is expected to be of a unilocular character and free, it may be found to be multilocular or solid and extensively adherent to the neighbouring parts.

Treatment.—The only effectual treatment is to remove the tumour by the operation of ovariotomy, an operation which, though formerly attended with a high rate of mortality, may now be said to be one of the most successful of the major operations in surgery. Repeated tappings, and tapping and injecting with tincture of iodine, have now very rightly almost ceased to be employed, although tapping may still at times be called for under exceptional circumstances, which cannot here be discussed. Before ovariotomy is undertaken, however, the patient should be very carefully prepared by attention to the bowels and kidneys, any congested condition of the latter being relieved by aperients, diaphoretics, warm baths, and the administration of citrate of potash, lithia, &c.

OVARIOTOMY.—The patient having been well wrapped up, with woollen stockings on the legs, &c., the bladder emptied by a catheter, the skin of the abdomen previously cleansed with soap and water and antiseptics, and the anæsthetic administered, a mackintosh cloth with an oval opening is placed over the abdomen and secured round the opening to the skin by adhesive material. The parts should then be again sponged with antiseptics, and an incision made in the middle line about three inches long midway between the pubes and the umbilicus (Fig. 305, a). This incision may be afterwards prolonged if necessary. The peritoneum having been reached, and all hæmorrhage stopped with pressure forceps, the peritoneal cavity is carefully opened on a director, the hand introduced, and adhesions felt for. If the cyst is free, Spencer Wells' trocar and cannula are thrust through the cyst-wall, the fluid evacuated, and the cyst gradually drawn out through the wound as it is reduced in size by the escape of the fluid. The pedicle is now transfixed by a long needle armed with a suture of China silk, the suture severed, and the needle withdrawn. The two portions of suture are next twisted, and the pedicle firmly tied on both sides. The pedicle is then divided on the cyst aspect, and the cyst removed, care being taken to prevent any of its contents escaping into the abdomen. If the cut surface of the pedicle appears dry, the sutures by which it is tied are cut off short, and it is allowed to slip back into the pelvis; but if any bleeding point is seen, this must first be secured. Should adhesions be felt on opening the abdomen, they should be carefully broken down by the hand, or divided if necessary, care being taken not to injure the intestines and to secure all bleeding vessels. After the cyst has been removed, the other ovary should be examined, and, if diseased, also removed. The sponging-out or irrigation of the abdomen is now begun, and must be continued as long as any blood-stained fluid can be squeezed from the sponges. The sponges should be thrust down deeply into Douglas's pouch, and when all the blood-stained fluid has been removed from this part of the peritoneum, a sponge attached by a string should be left there until just before closing the wound to ensure that no collection remains in this dependent situation. If irrigation is employed, an india-rubber tube attached to a can containing the irrigating fluid should be passed in various directions into the abdominal cavity, and the fluid allowed to flow until it runs away perfectly clear. The irrigating fluid may consist of boiled water at a temperature of 98 degrees, or water containing some mild antiseptic, as boracic acid. Mr. Tait uses ordinary tap water. A large soft sponge is finally placed over the surface of the intestines whilst the deep parietal sutures are being introduced. These should be passed about half an inch apart, and made to include the skin, peritoneum, and edge of the muscles, so that when tied two free surfaces of peritoneum are in contact. The sutures being all *in situ*, the flat sponge and the sponge in Douglas's pouch are withdrawn, the instruments and sponges counted, and the wound closed by tying the sutures. Superficial sutures are next introduced between the deep to ensure the accurate apposition of the skin. The mackintosh is now removed, a gauze-dressing firmly secured by strips of strapping, and a flannel bandage applied over all. Under some circumstances, as where many adhesions have been broken down, and there is likely to be oozing into the pelvis, or where the peritoneum has been accidentally soiled by septic material of any kind, a drain tube should be placed in the wound. The tube is passed through a tightly-fitting hole in the centre of a sheet of thin rubber (Fig. 392). The end of the tube should be then placed in the bottom of Douglas's pouch, and

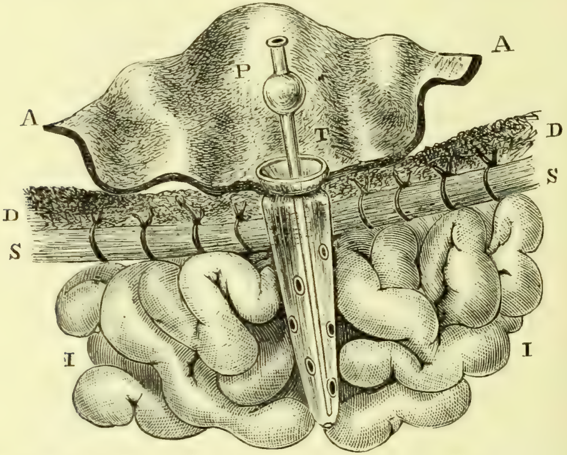

FIG. 392.—Method of draining after ovariotomy. A A. Rubber sheet. D D. Dressings. S S. Integuments. T. Drain-tube. I I. Intestines. P. Pipette.

the parietal wound closed except at the situation of the tube, and dressed with antiseptic gauze placed between the skin and the rubber sheet. Over the mouth of the tube an aseptic sponge is laid, and the rubber sheet wrapped around it so as to prevent any discharge from the tube reaching the permanent dressing. The rubber is unfolded at intervals, the sponge removed, and a capillary pipette passed down the tube to draw off any discharge that has collected. The tube is retained till the discharge ceases to collect in it and become of a serous character. *Broad ligament cysts* have to be enucleated from the capsule of peritoneum formed for them by layers of the broad ligament. The *after-treatment* consists in keeping the patient at rest, soothing pain and procuring sleep by morphia, emptying the bladder at regular intervals by the catheter, and allaying vomiting if present by teaspoonfuls of hot water, or if intractable by washing out the stomach. Tympanites is greatly relieved by the occasional passage of a long rectal tube. No food should be given for the first twenty-four hours; then nutrient enemata should be administered, and after three days a return to slop diet should be cautiously made. The stitches may be removed from the third to the seventh day, and the wound then supported by strapping. If signs of peritonitis appear, Mr. Tait gives a turpentine enema and saline purge. See *Peritonitis* (p. 397).

SALPINGITIS — HYDRO-SALPINX—PYO-SALPINX—HÆMATO-SALPINX.—As the result of gonorrhœa, septic inflammation of the uterus or pelvic peritoneum, and occasionally of parturition, the Fallopian tubes may become inflamed (*salpingitis*), and their orifices adherent, and as a consequence they may become distended with serum (*hydro-salpinx*) (Fig. 393) or with pus (*pyo-salpinx*); whilst much more rarely, as the result of an injury or from obstruction in the uterus or vagina, they may become distended with blood (*hæmato-salpinx*). The symptoms are pain, worse on exertion, straining, or coitus; and intensely painful, irregular or profuse menstruation, together with a history of uterine or ovarian trouble. On examination an ovoid, generally tender, perhaps fluctuating swelling will be felt externally and through the roof of the vagina, and on both sides if both tubes are affected. The swelling will be moveable or immoveable according as it is free or adherent, and may be distinguished from an ovarian cyst by its shape, and by being felt anteriorly rather than on either side of the neck of the uterus. Pyo-salpinx may generally be distinguished from hydro-salpinx by the occurrence of rigors and fever; but a diagnosis is often impossible.

Treatment.—The removal of the tube and ovary in the case of hydro- or pyo-salpinx is the treatment that has been adopted; but it should only be done when the symptoms are severe. Tapping through the vagina has not been attended with success. The operation of removal may be done in a manner similar to oöphorectomy. Hæmato-salpinx, as a rule, requires no active treatment.

OÖPHORECTOMY, or BATTEY'S operation, consists in the removal of the ovaries, and has been done for inflammation, neuralgia, menorrhagia, mollities osseum, fibroids, &c. The operation is performed like ovariotomy. A small incision being made in the linea alba, midway between the umbilicus and the pubes, two fingers are introduced into the peritoneal cavity, and first one, and then the other ovary brought out of the wound. The pedicle, which consists of broad ligament and its contained structures, is transfixed and ligatured as in ovariotomy, the ovary cut off, and the pedicle dropped back into the abdomen.

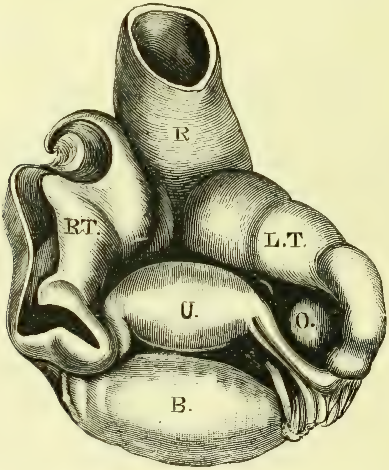

FIG. 393.—Double hydro-salpinx. B. Bladder. R. Rectum. R T. Right tube opened. L T. Left tube. O. Ovary. U. Uterus. (St. Bartholomew's Hospital Museum.)

HYSTERECTOMY, OR REMOVAL OF THE UTERUS, may be done through the vagina (*Schroeder's operation*) or through an incision in the abdominal walls (*Freund's operation*). In the former, an incision is made through the vaginal mucous membrane around the cervix, the peritoneal cavity opened, the broad ligament transfixed and ligatured, the cervix seized by vulsella forceps and drawn down, and the uterus severed from its connections and brought out through the vagina. In the operation through the abdominal wall, the peritoneal cavity is opened, as in ovariotomy; the broad ligament transfixed and ligatured; and the uterus drawn up from the pelvis and carefully severed from its connections. For a detailed account of these operations, however, the student is referred to a larger work.

DISEASES OF THE BREAST.

PAGET'S DISEASE OF THE NIPPLE, sometimes spoken of as eczema, is an intractable form of ulceration around the nipple. It lasts for many years, and yields to no treatment. A considerable proportion of cases develop carcinoma of the breast. Recently small animal parasites known as psorosperms have been described as existing in the tissues surrounding the ulcer, and are believed by some pathologists to be the exciting cause of the disease. *Treatment.*—When all mild measures are unavailing, many surgeons recommend amputation of the breast for fear of cancer subsequently forming.

NEURALGIA of the breast is not uncommon in young unmarried women, and appears to be frequently due to some ovarian disturbance. The pain is often severe, perhaps shooting down the arm, and may be constant or periodic; whilst the skin over the breast, as well as the gland itself, is exceedingly sensitive on handling. Nothing, except at times a slight fulness, can be detected on examination. The *treatment* consists in improving the general health by tonics, cold baths, and outdoor exercise, and in regulating the ovarian functions. No local treatment is necessary; indeed, the patient's attention should be taken off the breast as much as possible.

INFLAMMATION OF THE BREAST (*mastitis*) may occur at any age, and in the male as well as the female. In *infants* it is sometimes attended with a serous or milky discharge from the nipple, and is often made worse by ignorant nurses applying friction to "rub away the milk." *At or about puberty* it is met with in boys as well as in girls, but more frequently in the latter. Often beyond the patient appearing somewhat out of health no cause can be discovered, although in hospital patients a history of a blow is not uncommon. The inflammation may clear up, or terminate in an abscess.

ACUTE INFLAMMATION (*acute mastitis*), however, most frequently occurs during *lactation*, especially in primiparæ, and generally during the first month after parturition. It then appears to be most often due to the irritation of the nipple by the child sucking, particularly when the nipple is shrunken or retracted, or is in a cracked condition. Occasionally it is the result of excessive secretion of milk, and consequent hyperæsthesia of the ducts; or it may not appear till later during the period of lactation when the patient's powers have been pulled down by long suckling. The essential cause is of course the presence of pyogenic cocci, which may gain access by the blood, the lymphatics, or the lacteal ducts, the last being the most common.

Symptoms.—A feeling of uneasiness in the breast, then a chill or slight rigor, followed by fever and the local signs of inflammation, and often subsequently by abscess.

Treatment.—The breast should be placed at perfect rest by slinging it in a silk handkerchief passed over the shoulder, and by taking away the infant from the sound as well as from the affected side; the milk, if the tension is great, should be drawn off regularly by the breast-pump; and belladonna and glycerine applied to diminish the secretion, and opium or poppy fomentations to relieve pain. Signs of abscess must be watched for and an early incision made. A smart saline purge, followed by saline laxatives and a light nutritious slop diet, is usually necessary.

ACUTE ABSCESS OF THE BREAST may occur in three situations:—1. Superficial to the gland (*supra-mammary abscess*); 2. In the substance of the gland (*intra-mammary abscess*); and 3. Behind the gland (*post-mammary abscess*). 1. The supra-mammary variety resembles an abscess in any other situation and requires no further comment. 2. The intra-mammary, which is generally the result of inflammation occurring during lactation, may be confined to one part of the gland; or pus may be formed in several situations at the same time, and if not let out by timely incisions may riddle the breast in all directions. 3. In the post-mammary the inflammation begins either in the cellular tissue behind the breast, as the result of the breaking down of a hæmatoma following an injury, or in the posterior lobes of the gland, the resulting abscess then bursting into the cellular tissue behind the breast. The whole breast is pushed forward and presents a characteristic conical appearance. There is deep-seated and throbbing pain, increased on moving the arm, with some œdema and mottled redness of the skin. The pus usually gravitates towards the lower and outer part of the breast, where the abscess commonly points; or it may burrow through the gland, producing fistulous tracks which are often very difficult to heal.

Treatment.—In all varieties an early and free incision should be made, preferably under an anæsthetic. In the intra-mammary the incision should radiate from the nipple, so as not to cut across the galactophorous ducts; and should be free, not a mere puncture, lest the abscess cavity degenerate into a sinus. The finger should always be introduced into the abscess, and any septa between the main cavity and secondary recesses be broken down. In the post-mammary the incision should, by preference, be made at the most dependent part to ensure an efficient drain, though of course pus wherever pointing must be let out. Should sinuses or fistulæ form, they should be laid freely open and thoroughly drained, after being scraped by a Volkmann's spoon. The strength should be supported by a generous diet, and ammonia and bark, or quinine and iron given internally, together with stimulants, if indicated.

Chronic abscess of the breast is occasionally met with as the result of chronic inflammation following a slight injury, continued pressure as by the corsets, &c. It occurs as a distinct, ill-defined, slightly tender, hard, tense, or elastic, or perhaps distinctly fluctuating swelling, but is unattended by redness, œdema, or fever. The axillary glands may or may not be enlarged. Such an abscess has often been mistaken for a carcinoma. Free incision is the usual treatment.

Chronic lobular inflammation of the breast (*chronic mastitis*), has been described by various names, as lobular induration, chronic hypertrophy, chronic interstitial mastitis, &c. It generally affects one lobe, or limited portion of the gland, and is then liable to be mistaken for a tumour, or it may involve several lobules of the gland, giving it a peculiar shotty character, each nodule being separate from the other. It is said to be most frequent in married women beyond the child-bearing period of life; but my own experience is that it is as often met with in young and unmarried women.

Cause and Pathology.—It is generally attributed to ovarian disturbance, injury, pressure of the corsets, &c. A small-cell-infiltration occurs in the connective tissue of the affected lobe with increased proliferation of the epithelium in the acini. Later the cells or fibroblasts form fibrous tissue, which contracts, pressing upon and obliterating the ducts and acini, and causing degeneration of the epithelium lining them. Should some of the acini escape the pressure which has obliterated the ducts leading from them, small cysts may be formed; but such cysts seldom attain a large size in consequence of the unyielding nature of the fibrous tissue by which they are surrounded.

Symptoms.—The patient usually complains of a swelling, and sometimes of pain in the breast. On grasping the breast between the fingers the hypertrophied portion feels like a tumour, but on drawing it from the nipple so as to make the lactiferous ducts tense, it is found to be part of the mamma, and on pressing the breast back on the ribs with the flat of the hand no distinct tumour is felt, nor anything like the resistance of a new growth. Further, the swelling is usually of a wedge-shape, with its apex towards the nipple, and has not the stony hardness of scirrhus; and there may be a second nodule in the same breast, or in the breast of the opposite side. The axillary glands are sometimes enlarged, but are not indurated, and the pain often follows, as pointed out by Mr. Birkett, the distribution of one or more intercostal nerves, the slightest pressure upon which, as they issue from the thorax, causes acute pain. The above signs will usually serve to distinguish the affection from scirrhous carcinoma. Should, however, as occasionally happens, the nipple be retracted, the skin dimpled from the contraction of the fibrous septa, the surface of the gland rendered nodular by the presence of several tense cysts, and the patient moreover be about the age at which carcinoma is common, it may be difficult to diagnose between them, especially if the breast is voluminous so that the characters of the swelling are obscured. Under such circumstances it is quite justifiable to make an exploratory incision, after having explained the importance of a correct diagnosis to the patient.

Treatment.—Iron and quinine or the mineral acids are often indicated, and with these some combine the iodide of potassium. Locally a belladonna plaster may be applied, or the stays dispensed with to prevent friction, or a thick layer of cotton-wool placed between them and the breast. Inunction with iodide of potassium ointment, or with oleate of mercury, and strapping the breast are also recommended. Whatever treatment is adopted, it should be persevered in for several months.

There is a condition of *Hypertrophy* often met with in lads about the age of puberty, and in girls a little below that age. The breast enlarges slowly, often painlessly, generally on one, sometimes on both sides. There are no signs of inflammation. Under the influence of a belladonna plaster applied for some months, which probably owes its efficacy to the fact that it prevents the patient irritating the breast by constantly feeling it, the hypertrophy usually subsides. Of its exact pathological condition I am not aware, but it is generally thought to be of a chronic inflammatory nature.

MULTIPLE CYSTIC DISEASE OF THE BREAST is an occasional termination of chronic lobular mastitis. One or more of the small cysts formed in this disease become enlarged and filled with a yellow or brownish yellow serous or mucoid fluid, and give rise to a distinct tense, elastic, hard, smooth swelling or swellings in the breast, whilst smaller swellings due to the smaller cysts may be felt scattered through its substance. Both breasts are frequently affected simultaneously. The larger cysts may be dissected out, or the whole breast under some circumstances may with advantage be removed.

TUBERCULOUS DEPOSIT is not so very uncommon. In appearance it resembles somewhat chronic mastitis, for which it is often mistaken. The deposit usually takes place in or around an acinus, increases somewhat rapidly in size, and finally, after degenerating into a caseating mass, breaks down and discharges. When suppuration has been established, sinuses extend through the breast in all directions unless promptly treated. The milk secreted by a tuberculous breast contains numerous tubercle bacilli. *Treatment.*—This depends upon the age of the patient. If old and beyond the child-bearing period, the treatment may be confined to opening the abscesses when they form, and slitting up and scraping such sinuses as may exist, while at the same time a good nourishing diet is enjoined, together with the internal administration of cod liver oil and tonics. Should, however, the patient be a young woman, who has borne and is still capable of bearing children, the safest plan is to amputate the breast, the only means of safeguarding the children from infection by tubercle bacilli when suckling.

SYPHILIS OF BREAST.—The primary, secondary and tertiary forms of syphilis are all found affecting the breast. The *primary sore* usually takes the form of a painless fissure which refuses to heal. It is occasioned through suckling a syphilitic infant, and is found upon the nipple of the wet-nurse, and not upon that of the mother of a child the subject of hereditary syphilis. During the *secondary stage* of syphilis, condylomata are sometimes found upon the nipple and areola. They have the appearance of condylomata elsewhere, and are highly infecting. The *tertiary form* of the disease occurs as gummatous deposits, and is extremely rare. The gummata occur as well-defined, circumscribed, hard, painless masses, increasing more or less rapidly in size and tending eventually to soften and break down into characteristic tertiary ulcers. They have to be diagnosed from tuberculous deposit, chronic mastitis, and scirrhous carcinoma.

TUMOURS OF THE BREAST.—The tumour by far the most frequently met with in this situation is the acinous carcinoma (*scirrhus*), which is due to the proliferation of the epithelium lining the acini or the small ducts. Certain of the connective-tissue tumours (*fibromata, sarcomata*), springing from the periacinous connective tissue, are also of frequent occurrence. They seldom, however, occur pure, but are nearly always mixed with elements resembling the tissue of the breast itself (*adenomatous tissue*), and hence are spoken of as adeno-fibroma, adeno-sarcoma, adeno-myxoma. Whether these adenomatous elements are the normal breast-tissue which has become surrounded and enclosed in the fibrous or sarcomatous growth as the case may be, or whether it is an abortive formation of the gland-tissue, is not agreed upon by pathologists. Many, however, believe that it is a new formation. More rarely the gland-tissue may constitute the chief bulk of the tumour (*pure adenoma*). The tumours composing this class were formerly spoken of collectively as *chronic mammary glandular tumours*. At times cysts are developed in connection with them, and they are then designated *cystic adeno-fibroma*, *cystic adeno-sarcoma*, *cystic adeno-myxoma*, &c. Various other forms of tumour, viz., tumours composed of fat, cartilage, vessel-tissue, nerve-tissue, &c., have also been met with in the breast, but are exceedingly rare.

PURE ADENOMATA are very rare. They occur as circumscribed ovoid tumours surrounded by a capsule of connective tissue. On section they appear smooth, lobed, white or tinged with pink, with here and there small cavities and occasionally distinct cysts. Their general characters have already been given under *Tumours*. All that need here be repeated is that they consist of acini and ducts surrounded by a small amount of vascular connective tissue; in short, that they resemble the breast preparing for lactation, save that the acini and ducts do not form distinct lobules with an excretory duct, as in the lactating breast. Further, the epithelium does not penetrate the membrana propria and grow into the inter-tubular and inter-acinous connective tissue, a point of importance as distinguishing them from carcinoma.

Signs.—They are most often met with in women between the ages of thirty and thirty-five who have borne children, as small ovoid, firm but elastic, distinctly circumscribed and moveable growths in the breast, with a nodular or slightly bossed surface. They are of very slow growth, do not cause retraction of the nipple or enlargement of the axillary glands, and do not return if completely removed. *Treatment.*—Enucleation should be practised, the breast, whenever possible, being turned up by a semilunar incision around its lower margin. In this way the scar does not show when a low-necked dress is worn.

ADENO-FIBROMATA are of frequent occurrence. They consist of fibrous and adenomatous tissue, and are styled *fibromata* by those pathologists who regard the gland-tissue as merely the remains of the normal breast-tissue surrounded by the new growth. They occur as firm, circumscribed, slow-growing and distinctly encapsuled tumours in the substance of the breast, and on section appear lobulated and of a pinkish-white colour, and do not yield a juice on scraping.

Signs.—They usually occur in the breast of young and healthy women as freely moveable, firm, ovoid, slightly nodular, generally painless growths, and are often indistinguishable, without puncture, from a tense cyst. From carcinoma and sarcoma they may be diagnosed by the age of the patient, their slow growth, well-defined outline, non-retraction of the nipple, non-adherence of the skin, and the absence of glandular enlargement. From pure adenoma, adeno-sarcoma, and adeno-myxoma, it may be impossible to distinguish them before removal. Enucleation is the only effective *treatment*.

ADENO-SARCOMATA differ from the adeno-fibromata in that, in place of an increase of fibrous tissue around the acini and ducts, various kinds of sarcomatous elements are found mixed with more or less mature fibrous or myxomatous tissue; they often contain cysts. Hence the terms adeno-fibro-sarcoma, adeno-myxo-sarcoma, adeno-cysto-sarcoma, fibro-cysto-sarcoma, &c., which have been applied to them. They occur as circumscribed growths in the breast, resembling the adeno-fibromata, from which it is often impossible to distinguish them without a microscopic examination.

The signs vary according to the amount of sarcoma-elements the growth contains. Thus, when this is small they approach in their clinical character and behaviour the adeno-fibromata. On the other hand, when sarcoma-elements abound, they may grow rapidly, and behave like the pure sarcomata. Frequently they grow slowly for many years and then suddenly rapidly increase in size as the patient approaches the middle period of life. When occurring between the ages of thirty and forty they often grow rapidly from the first.

Treatment.—The slow-growing and more fibrous forms may be enucleated, but if in proceeding to do this the growth is found to be soft and succulent the whole breast should be excised, an operation that should invariably be undertaken when the tumour has grown rapidly.

PURE SARCOMATA.—All forms of sarcoma mixed with fibrous and adenomatous elements may occur in the breast, the large spindle-celled variety being the most common. Sarcomata are most frequent between the ages of twenty and thirty-five. They begin in the periacinous and peritubular connective tissue, and at first are always encapsuled, but later they infiltrate the surrounding parts and may perforate the skin and fungate. Their malignancy depends upon their structure, the round-celled and large-spindle-celled being highly malignant, the small-spindle-celled much less so; indeed the latter may recur again and again *in situ* before finally becoming disseminated, or its tendency to recurrence may completely wear itself out. The small-spindle-celled is usually firm like the adeno-sarcomata, and on section greyish-white, smooth and succulent. The round-celled and large-spindle-celled are soft and elastic owing to their richness in cells and blood-vessels and their scanty amount of intercellular substance. On section they appear of a pinkish-white colour, often blotched with blood, while cysts from hæmorrhages and mucoid softening sometimes occur in them.

Signs.—The small-spindle-celled sarcoma can hardly be diagnosed before removal from the adeno-fibroma and adeno-sarcoma. The large-spindle-celled and round-celled varieties form smooth elastic tumours, oval or rounded in shape, and are lobed or bossed when cystic; whilst the veins of the breast are often enlarged and tortuous. They grow rapidly, and may perforate the skin and protrude as a fungus; but, unlike carcinoma, they do not infiltrate the skin or cause retraction of the nipple, and the glands are not usually enlarged. The tumour, moreover, is commonly larger than scirrhus, and the patient's age below that at which carcinoma is usually met with.

The only effectual *treatment* is the removal of the whole breast. If there is any doubt whether the tumour is an adeno-fibroma or a sarcoma it is better to have the consent of the patient before the operation for the removal of the whole breast, should the tumour, when cut into, appear to have malignant characters.

ADENO-CYSTOMATA, cysto-sarcomata, sero-cystic sarcomata, and glandular proliferating cysts, are terms applied to tumours in the breast in which the growth in the periacinous connective tissue projects into the interior of dilated acini and ducts in the form of papillary or cauliflower-like masses. The periacinous growth, which may consist of fibrous tissue, spindle or round cells, or of a mixture of all these, protrudes the wall of the dilated acinus or duct in front of it, but does not penetrate the epithelial lining, and may ultimately fill the whole acinus, which is thus converted into a mere slit-like space lined with epithelium. On section the tumour may present one or more larger cysts, containing variously-shaped cauliflower-like growths sprouting from their walls. Or it may appear completely solid, from the cysts having been entirely filled with intra-cystic growths; on dissection, however, the spaces between the growths and the cyst-walls can always be demonstrated (Fig. 394). When the growth, which is at first encapsuled, attains some size, the skin may give way and the growth protrude in the form of a fungus. The skin, however, does not become infiltrated as in carcinoma.

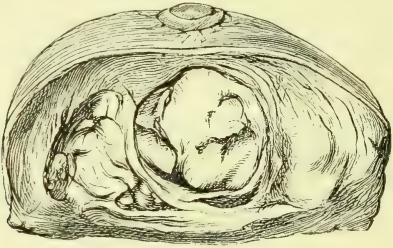

FIG. 394.—Cystic adenoma of the breast.
(St. Bartholomew's Hospital Museum.)

Signs.—They generally occur in women between the ages of thirty and thirty-five, as distinctly defined, lobulated, usually painless growths, hard in some places and soft and fluctuating in others, and often of large size. The veins over them are enlarged, but the skin is not adherent, the nipple is not retracted, and the glands as a rule are not affected. They commonly grow slowly, but at times rapidly, and seldom or never become disseminated. Their chief distinguishing characteristic is the presence of one or more prominent fluctuating cysts in the tumour. Should a fungus protrude it may be distinguished from carcinoma by the non-implication of the skin around, non-adherence of the growth to the side of the chest, and the absence of the other signs of carcinoma above pointed out. Removal of the breast is the proper *treatment.*

Cysts.—The cysts met with most frequently in the breast are the serous cysts, and certain of the retention cysts. *Serous cysts* are formed in the breast, as in other situations, by the distension with fluid of the lymphatic spaces of the connective tissue (see *Serous cysts*). The *retention* cysts that occur in the breast may be divided into the *galactoceles*, which are produced by the dilatation of the galactophorous ducts, and the *glandular* cysts, due to the distension of the smaller ducts and acini. The former contain a milk-like fluid, or when, as occasionally happens, the watery parts have been absorbed, an inspissated caseous material. The glandular contain a yellowish or brownish-yellow mucoid fluid, sometimes blood-stained, and at times intracystic papillary growths, formed by the ingrowing of the cyst walls. When they occur in elderly people they are spoken of as *involution* cysts. Their frequency in chronic lobular inflammation of the breast has already been alluded to.

Signs.—Cysts in the breast form painless, tense, or semifluctuating, smooth, rounded tumours, evidently connected with the breast tissue. *Serous cysts* may occur in any part of the breast. They are often very tense and hard, and breasts with such in them have been removed for cancer. Hence the valuable rule of making a preliminary incision if in doubt as to the nature of the tumour. The *galactoceles* occur during lactation; they are situated near the nipple, from which a milk-like fluid may sometimes be squeezed out on pressing the cyst. They are soft and fluctuating, and usually single, form quickly, and may attain a large size. *Glandular* cysts occur chiefly in women of from thirty-five to fifty. They are tense and painless, form slowly, may occur singly, but are often multiple. A sanious fluid sometimes escapes from the nipple if the cyst contains a papillary growth.

Treatment.—*Simple serous cysts* may be laid freely open and allowed to granulate from the bottom, or, better, be dissected out. *Galactoceles* with semi-solid contents may also be laid freely open and their contents squeezed out. *Glandular cysts*, when numerous, call for the excision of the affected lobule, or if the whole breast is affected and they contain proliferating growths, excision of the entire gland. *Involution cysts* require no treatment.

Carcinoma of the breast is nearly always of the acinous form, of which both varieties, the hard (*scirrhous*) and the soft (*medullary*), are met with. The hard variety, however, is by far the most common. The general and microscopical characters of carcinoma have already been given under Tumours. Here only the special characters which it presents when occurring in the breast will be referred to.

SCIRRHOUS CARCINOMA. — *Pathology.* — Scirrhus of the breast generally appears as an indurated, nodular, non-encapsuled, tuberous mass, of moderate dimensions, with long processes extending in various directions in the gland-substance and the fatty tissue around, and later, involving the skin and subjacent pectoral muscle. On section (Fig. 395) the tumour gives a characteristic creaking sensation to the knife, and the cut surface appears slightly concave from the contraction and shrinking of its fibrous stroma thus set free from the traction of surrounding tissues. It is of a hard resisting consistency, of a uniform close texture, semi-translucent, of a greyish-white colour often tinged with pink, and has been likened to the section of a potato or unripe pear. Sometimes it is intersected in every direction by short wavy glistening white fibres, with here and there yellow dots and streaks due to section of the epithelial columns which have undergone fatty degeneration; whilst in other places, little masses of the surrounding fatty tissue and of muscle are seen enclosed by the processes of the growth; and patches of caseous-looking material or white creamy fluid, due to the growth having surrounded some of the ducts which have become only partially obliterated, may be scattered through its substance. The section on scraping yields a juice containing cells, free nuclei, and granular material.

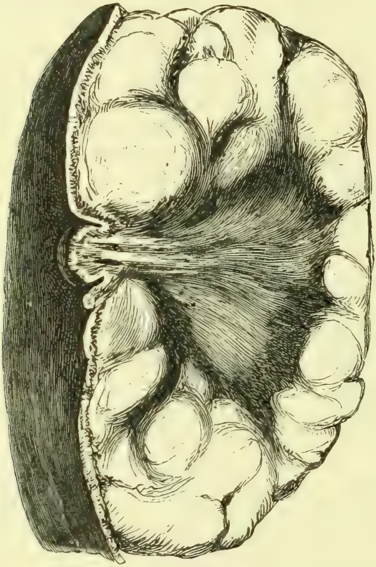

FIG. 395.—Scirrhous carcinoma of the breast. (St. Bartholomew's Hospital Museum.)

Signs.—Scirrhous carcinoma generally begins as a small hard lump in the substance of the breast; it grows slowly at first, afterwards more rapidly, and then involves the skin and pectoral muscle; finally the skin gives way, and a foul ulcer is produced. In the meantime, the lymphatic glands in the axilla become involved, and as they increase in size press upon the axillary vein and brachial plexus of nerves, producing œdema of the arm and intense neuralgic pain. Later the cancer becomes disseminated through the internal organs and tissues of the body. The health, which on the first appearance of the growth is generally good, now gives way, the skin becomes sallow and earthy in appearance, the patient wasted, and cancerous cachexia is said to be present. The foul and profuse discharge from the ulcer, the intense pain, the mental suffering, and the implication of internal organs, lead to exhaustion, and death soon steps in to put an end to the patient's misery. Such is a brief outline of the course of the disease when not subjected to surgical interference. Let us now study the characters of the tumour as presented in a typical case. It is usually situated in the upper and outer quadrant of the breast, or just below the nipple. Its surface is hard and irregular, its margins ill-defined. The skin at first, when gently pinched up between the finger and thumb, shows a slight dimpling, and later appears distinctly puckered and unmistakably adherent to the growth. In the earlier stages the tumour glides freely over the pectoral muscle; later a slight resistance is felt on moving it from side to side; whilst finally it becomes firmly fixed to the walls of the chest. The nipple, when the growth is behind it, is retracted, in consequence of the traction which is made by the carcinoma upon the lacteal ducts (Fig. 395); but when the growth is situated in the circumference of the breast, there may be no retraction, or the retraction may occur only on one side; whilst when the cancer begins as an infiltration of the nipple itself, the latter will be harder and more prominent than natural. On raising the arm and drawing the finger-tips transversely across the inner side of the axilla, a hard cord or cords—infiltrated lymphatic vessels—may often be felt extending from the tumour into the axilla, while in the space itself large glands will be discovered if the case is sufficiently advanced. The glands are at first soft, single and distinct, later, hard and matted together, forming an indurated irregular mass which is often adherent to the chest-walls and in advanced cases extends as high as can be felt beneath the clavicle. In the supraclavicular space the enlarged glands may sometimes be detected, first as a mere fulness, subsequently as distinct swellings. After the skin over the tumour has given way, an ulcer with sinuous, irregular, everted, and indurated edges, and a foul, cavernous, irregular, and indurated base is formed, from which is exuded a foul-smelling and sanious discharge. The skin around is indurated from infiltration with the growth; or distinct, circumscribed, hard nodules of carcinoma are scattered here and there through it.

Diagnosis.—When the above signs are present there is no difficulty in pronouncing as to the nature of the disease. In the earlier stages, however, whilst the tumour is still small and has not yet become adherent to the skin or to the pectoral muscle, where the breast is large and there is no retraction of the nipple and as yet there is no enlargement of the axillary glands, the diagnosis from an innocent tumour, a tense cyst, or lobular inflammation will be, to say the least, difficult. The age of the patient, the rate of growth, and the history of the case must then to a great extent be relied on for distinguishing it. But where the patient, as is occasionally the case, is young, the diagnosis may then be impossible without making an incision into the growth, a proceeding which, under such circumstances, after the difficulty has been explained to the patient, is not only justifiable but imperatively called for.

Rarer forms of scirrhus in the breast are occasionally met with. Thus—1. The cancer may begin as a general infiltration of the entire gland, when its course is usually very rapid; 2, it may chiefly affect the lymphatics of the skin, the whole side of the chest in such a case becoming infiltrated, hard, brawny and leathery in consistency, a condition known as "hide-bound;" 3, it may begin as an infiltration of the nipple, or may be engrafted upon chronic eczema around the nipple; 4, in elderly women it may run a very chronic course, often remaining stationary, if not interfered with, for many years (*fibrous or chronic cancer*); and 5, in very exceptional instances, the carcinomatous mass has apparently undergone complete atrophy, even, it is said, after ulceration has occurred, and a spontaneous cure has thus been brought about.

Treatment.—In the breast, as elsewhere, the only hope of cure lies in the early and complete extirpation of the carcinoma. Unless, therefore, the surgeon is consulted before the skin, pectoral muscle, and lymphatic glands are more than slightly involved, he can hold out but little prospect that the disease will not return, and return shortly, or that life will be materially, if at all, prolonged by an operation. Under such circumstances, therefore, there are some surgeons who hold that an operation with the disease thus advanced ought not to be undertaken, as it can only bring discredit on surgery and may possibly prevent other patients seeking advice whilst there is yet a probability that a free and complete removal of the breast and axillary glands may eradicate the disease. While admitting that this may be true, we must not lose sight of the fact that even although the growth may soon recur either in the cicatrix or glands, or in internal organs, and although life may not be prolonged, still removal of the growth may rid the patient of a foul and loathsome disease and often of great pain, at any rate for a time, and death may occur in a less distressing way from dissemination of the carcinoma in internal organs. In the meanwhile the patient's mind will be relieved, even if she is not buoyed up with the hope that there may still be a chance of a non-return. Regarding the question of operation, therefore, it may be briefly said that—1. Where the skin is not involved, or to a very slight extent, the tumour not adherent to the pectoral muscle, and the glands are not felt enlarged, or if enlarged are not adherent to the chest wall, free removal of the breast and, in all cases, clearing out the axilla is imperatively called for. 2. Where, on the other hand, the skin is extensively infiltrated, the tumour is firmly adherent to the pectoral muscle, the glands are enlarged, hard, and adherent to the side of the chest, enlarged glands can also be felt above the clavicle and perhaps have already caused œdema of the arm, marked cachexia is present and there is evidence of dissemination of the carcinoma in other organs and tissues—then no operation should be performed. In cases such as the above, there can be little question as to the propriety of operating or not operating. But there are a large class of intermediate cases in which some surgeons would, and some would not, operate. Much will then depend upon the presence or absence of pain, the age of the patient, &c., and each case must be judged on its own merits. When too far advanced to permit of removal, all that can be done is to relieve pain and procure sleep by opium or morphia, and support the strength by a liberal diet and stimulants. Should an ulcer have formed it may in some cases be treated with caustics, as Bougard's paste or pyoktanin, or dusted with iodoform or charcoal to control the fœtor.

MEDULLARY CARCINOMA is much less common in the breast than the scirrhous form, and generally appears at an earlier age. It occurs as a soft, non-encapsuled, compact, white or blood-stained, brain-like mass infiltrating the gland and surrounding tissues. Its growth is much more rapid than the scirrhous variety, and it sooner involves the skin, pectoral muscles, and axillary glands, and rapidly becomes disseminated through internal organs. Early and free removal of the whole breast, and the complete clearing out of all glands from the axilla, is the proper *treatment*.

Other varieties of carcinoma in the breast, as the so-called *villous*, or *duct cancers*, and the *colloid*, require only a brief notice.

DUCT CARCINOMA occurs as one or more rounded masses lying in the breast tissue not far from the nipple. On section these masses appear as red, encysted and defined tumours (Fig. 396). Microscopically they are columnar-celled carcinomata, and they frequently consist of cysts, which often contain blood, and into which papillary growths, covered by columnar epithelium, sprout. The growths have an alveolar structure, and closely resemble, microscopically, especially when the disease has recurred, ordinary encephaloid carcinoma.

Signs.— The nipple is not, as a rule, retracted, but there is usually a history of a discharge of blood from it, often before a tumour is noticed. In the specimen, of which Fig. 396 is a drawing, there was very slight retraction of the nipple. The skin is not infiltrated, the axillary glands are not enlarged, and secondary deposits are very rare. The tumour is firm and elastic, and may contain one or more cysts. It usually occurs in middle age, is of slow growth, and not accompanied as a rule by pain. The *treatment* consists in amputation of the whole breast. If this is done, no further trouble usually occurs.

Colloid carcinoma of the breast is very rare. Its structure is like that of scirrhous or encephaloid cancer, but here and there large epithelial cell-masses have undergone colloid degeneration. It is of slower growth, and less frequently affects the glands than either scirrhous or encephaloid cancer, and has a less tendency to recur after removal. The prospective length of life is said to be three or four times that of ordinary scirrhus.

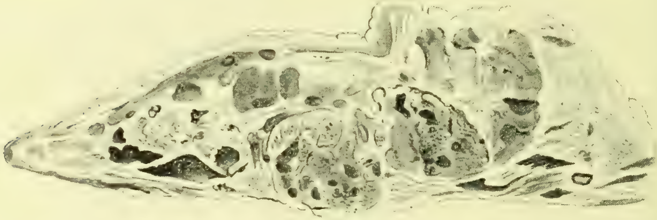

Fig. 396.—Section of a duct carcinoma of the breast. The tumour has well-defined edges, and is composed of a number of cysts containing growths and broken-down blood. (St. Bartholomew's Hospital Museum, No. 3,186 *f.*)

Excision of the breast.—The arm being held out from the side by an assistant so as to put the pectoral muscle on the stretch and well expose the axilla, an elliptical incision should be made below and another above the nipple, cutting widely of any adherent or infiltrated skin. The skin above and below should now be reflected from the breast, and the latter dissected off the pectoral muscle, taking care to remove the pectoral fascia and any portion of the muscle that appears affected with the disease. Should any gland be felt in the axilla before removing the breast, the incision should be prolonged in an upward and outward direction, the axillary vein exposed, its branches extending into the axilla clamped and tied, together with any small arteries that lie just behind them, the glands dissected off the veins, and these, with the lymphatics running to them, removed with the breast in one mass. In this way there is less hæmorrhage, and all the infected lymphatic tissue is removed. In fat persons it may be necessary to divide the pectoralis major in order to remove effectually all the glands, especially those situated between the pectoral muscles and high up in the axilla. The skin should now be drawn together by sutures, a drainage tube having been placed in the deeper part of the wound. Where the skin cannot be made to cover in the wound, the flaps should be drawn as much together as possible by stout fishing-gut sutures, and the remainder of the wound left to granulate, or flaps may be made by dissecting up portions of skin from over the latissimus dorsi. The arm should be secured to the side with the forearm and hand across the chest. Some surgeons, with a view to the more complete removal of the disease, cut the pectoral muscles away. This procedure is followed by so much contraction and subsequent interference with the movement of the arm, that I do not advise it save under exceptional conditions, as when the pectoral is extremely infiltrated. It does not ensure the complete removal of the disease since the mediastinal glands may be affected.

DEFORMITIES OF THE NECK, KNEES AND FEET.

WRY-NECK OR TORTICOLLIS is a distortion chiefly dependent upon contraction of the sterno-mastoid muscle. It may be congenital or acquired.

Causes.—The *congenital form* is attributed to—1, spastic contraction of the sterno-mastoid muscle due to disease of the nervous system; 2, malposition *in utero;* or, 3, injury at birth, as, for example, rupture of the sterno-mastoid in a breech presentation. The *acquired form* is due to—1, the head having been held for a long time in the distorted position as a consequence of stiff neck following cold, rheumatism, injury, or inflamed cervical glands; 2, hysteria; or, 3, spasm set up by irritation of the spinal accessory nerve consequent upon central nerve-trouble.

Signs.—The head, supposing the right sterno-mastoid to be affected, is drawn forwards and towards the right shoulder and also rotated, so that the chin points to the left. The right mastoid is prominent, the right side of the neck concave, and the left convex. In long-standing cases some lateral curvature of the dorsal spine is generally acquired. The congenital form may be distinguished from the spasmodic not only by its history but by the sterno-mastoid becoming tense in the former, and yielding in the latter, on attempting to straighten the head. The hysterical variety will be known by the presence of other signs of hysteria.

Treatment.—In *congenital wry-neck,* unless the patient is treated by position while still an infant, division of the sterno-mastoid is generally required, followed by a course of systematic exercises in the slighter cases, and the use of some such instrument as that shown in Fig. 397, in the most severe. The sterno-mastoid is best divided immediately above the clavicle, as here it is furthest removed from the important structures that lie beneath it. A puncture should be made at the inner side of the tendon, a director passed behind it, and the division made towards the skin with a blunt-pointed tenotome. The tense bands of contracted cervical fascia which now start forward will yield to stretching; it is not safe to divide them. The head should be straightened and thus held by a bandage and sand-bags. The puncture should be given three or four days to heal before the exercises are begun or the instrument is applied. Some advise the division of the muscle about the middle on the plea that such is a more safe procedure; whilst others again recommend the division of the tendon by open incision, as in this way the danger of puncturing and admitting air into a vein is avoided. If the subcutaneous division, however, is carefully done in the manner here advised, I do not believe there need be any fear of air entering the veins. I have now performed this little operation many times and have never experienced any difficulty or trouble. At the same time it is only right to state that sudden death has occurred in the hands of some excellent surgeons, and others have met with alarming symptoms. In *spasmodic* cases conium, Indian hemp, bromide of potassium, &c., may be tried. These failing, the spinal accessory nerve may be stretched just above the spot where it enters the sterno-mastoid. In very intractable cases a piece of the nerve may be excised, and if the posterior cervical muscles are also involved in the spasm, excision of portions of the posterior divisions of the first four cervical nerves may be simultaneously or subsequently undertaken. Tenotomy of the sterno-mastoid should in these and in hysterical cases on no account be done. In the latter, hysterical remedies should of course be used.

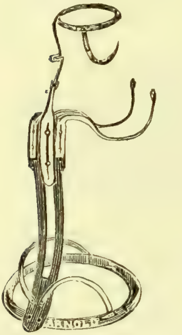

FIG. 397.—Wry-neck apparatus.

KNOCK-KNEE OR GENU VALGUM is a deformity in which, when the knees are placed together in the extended position with the patellæ looking directly forwards, the legs diverge. One or both knees may be affected, or there may be genu valgum on one side and genu varum on the other.

Cause.—Knock-knee is generally the result either of rickets, when it occurs between the second and the seventh year; or of carrying heavy weights, long standing and the like, when it is most common in growing, underfed and overworked lads and girls from fourteen to eighteen. The deformity is variously believed to depend on:—1, an overgrowth of the internal condyle of the femur, and a corresponding uprising of the inner tuberosity of the tibia; 2, the relaxation of the internal lateral ligament; or 3, the contraction of the biceps tendon. In the majority of cases the osseous lesion is certainly present, and I have no doubt in my own mind that it is upon this that the deformity in rickety cases usually depends, though I admit that in some of those rapid cases induced by excessive weight-bearing in weakly lads a relaxation of the ligaments may be the principal factor. The contraction of the biceps tendon when present I regard as the result, and not as the cause of the affection.

Treatment.—In slight rickety cases, keeping the child entirely off its legs, the application of splints, and the internal use of appropriate remedies, will generally effect a cure. In confirmed cases, and in older patients, however, little must be expected from splints or instruments. By their use the limb can no doubt be straightened, but only at the expense of stretching the external lateral ligament, the legs being rendered flail-like, and the patient being unable to walk or even stand without his irons. For such some form of osteoclasia or osteotomy is usually required.

OSTEOCLASIA consists in breaking the bone either with the hands or with the *osteoclast*. Manual osteoclasia is seldom employed except for the correction of rickety bow-legs or knock-knee in young subjects when the bones are moderately soft. For fracturing larger and stronger bones the osteoclast is required. The limb is properly adjusted between the arms of the instrument and the force applied by means of a screw in Grattan's osteoclast or by levers in that of Thomas.

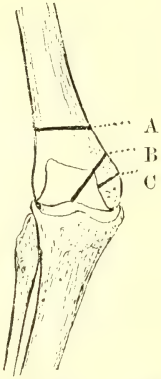

FIG. 398.—A, line of section in Macewen's; B, in Ogston's; and C, in Reeves' modified Ogston's operation.

OSTEOTOMY is usually done by Macewen's or Reeves' modified Ogston's method. 1. *Macewen's operation* consists in chiselling through the femur just above the epiphysis, but leaving the posterior surface, which is in contact with the popliteal artery, intact, and snapping this across by forcibly bending the bone. 2. In *Reeves' modification of Ogston's operation* the internal condyle is first loosened with a chisel, and then made to slide upwards on the shaft of the femur by forcibly straightening the leg. The chisel is introduced behind the synovial membrane and should not be driven so far into the condyle as to endanger the opening of the joint. The line of incision through the femur in these operations is shown in Fig. 398. The incision in the soft tissues which in either operation should be merely long enough to admit the chisel, may in each be made vertically two fingers' breadth above the patella and midway between the inner edge of the rectus and the tendon of the adductor magnus. The operations should be performed antiseptically and the limb secured to a long splint, or placed in Bavarian plaster splints in a straight position for about a month, and subsequently kept in an ordinary plaster case for six weeks to two months till sound union has taken place.

GENU VARUM, OR BOW-LEGS, is the opposite deformity to genu valgum, and what has been said of the latter as regards pathology, treatment, &c., will apply to it if external be substituted for internal in the phraseology. It is frequently associated with a bowing of the shaft of the tibia, either at its upper or its lower third, and sometimes with a bowing of the femur.

GENU RECURVATUM OR EXTRORSUM is a condition of over-extension at the knee. It is frequently present in a slight degree in cases of knock-knee. It sometimes occurs as a congenital affection; the hyper-extension may then be extreme, the feet touching the groins. When it is combined with knock-knee the irons for the latter affection should have a front stop. In congenital cases division of the quadriceps may be necessary, but continual attempts at flexion and the use of an instrument with a cog-wheel at the knee will usually suffice.

TALIPES OR CLUB-FOOT is a distortion in which the relations of the tarsal bones to each other and to the bones of the leg are variously altered, and the bones held in their abnormal position by alteration in the shape of the bones and by the contraction or shortening of certain of the muscles, ligaments, and fasciæ attached to the foot.

Cause.—Talipes may either be congenital or acquired.

The *congenital* form has been attributed to—1, spastic muscular contraction induced by some lesion of the nerve-centres; 2, malpositions of the fœtus *in utero;* 3, structural alteration in the form of some of the tarsal bones. The supporters of the first view maintain that the bones are drawn into their abnormal position by muscular contraction, and regard any alteration in the shape of the bones as the result and not as the cause of their malposition; whilst those who uphold the second and third views deny that spastic contraction occurs, as no lesion of the nerve-centres has been found to account for it, and look upon the contraction of the muscles as merely due to adaptive shortening consequent upon the altered position of the bones. The congenital variety is sometimes hereditary, very occasionally occurs in several members of the same family, and is frequently associated with other congenital malformations as spina bifida, meningocele, &c. The *acquired* form is generally the result of infantile paralysis, the bones then either being drawn into their abnormal positions by the contraction of the muscles antagonistic to those paralysed, or falling into the abnormal positions by the weight of the foot. In either case the weight of the body in standing and walking tends more and more to confirm this faulty position. Amongst other causes may be mentioned long-continuance of the foot in the extended position, disease of the ankle or tarsus, yielding of the ligaments, &c.

Varieties.—There are five principal forms of club-foot:—*Talipes equinus*, *varus*, *calcaneus*, *valgus*, and *cavus*. But these may be variously combined, producing compound forms, which are then called *equino-varus*, *equino-valgus*, *calcaneo-valgus*, &c.

1. *Talipes equinus* (Figs. 399, 400) is nearly always an acquired affection, and generally due to infantile paralysis of the anterior or extensor muscles; as a congenital affection it is very rare. I have only seen two cases during the fifteen years I have had charge of the orthopædic department of St. Bartholomew's. The heel is drawn upwards by the tendo Achillis, and the anterior part of the foot is in consequence depressed and held in the extended position. The weight of the body is thus transmitted through the heads of the metatarsal bones, which, together with the anterior part of the tarsus, are bent downwards and backwards from the transverse tarsal joint and fixed in this position by the adaptive shortening of the plantar fascia, ligaments and muscles, thus rendering the sole of the foot unnaturally concave, a condition known as *pes cavus*. The patient walks with fatigue and lameness on the balls of his toes (Fig. 399), and if both feet are affected he may be unable to walk at all. When the extensor muscles of the toes are completely paralyzed the toes may be bent under as shown

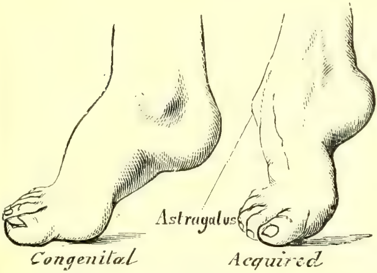

Fig. 399.—Talipes equinus. (Bryant's Surgery.)

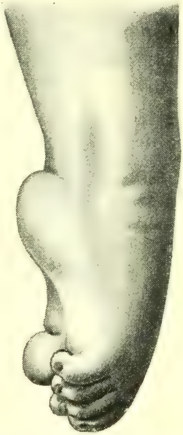

Fig. 400.—Talipes equinus, with complete paralysis of the anterior muscles.

in Fig. 400, and the patient walks on the dorsum of the toes, or even on the dorsum of the foot. Corns and perhaps ulcers are then formed, rendering walking exceedingly painful or impossible. In long-standing cases, in consequence of the contraction being greater on the inner than on the outer side of the sole, an inward twist is given to the foot (*equino-varus*). At times the tendo Achillis is not sufficiently shortened to draw up the heel, but at the same time is so contracted as to prevent the foot being placed beyond a right angle with the leg. This condition is spoken of as *right-angled contraction* of the tendo Achillis or as *rectangular talipes*.

2. *Talipes varus* is the most complicated variety of club-foot, and is the most common of the congenital forms. By some the distortion here described as varus is called *equino-varus*. I prefer, however, to apply the simple term varus to the form under consideration, and equino-varus to cases of equinus in which there is added a secondary twisting inwards of the foot. In varus (Fig. 401), the os calcis is drawn up by the tendo Achillis, tilting the astragalus partially out of the ankle-joint, and the bones in front of the transverse tarsal joint are drawn inwards and upwards by the tibialis anticus and posticus, so that the scaphoid is placed internal to the astragalus instead of in front of it, whilst its tuberosity is in close contact with the internal malleolus. The ligaments on the inner side of the sole and between the tibia and astragalus are shortened, and are often the chief agents holding the bones in their deformed position. In severe cases, however, the astragalus is itself deformed, its head looking almost directly inwards instead of forwards and slightly inwards. Thus, in a well-marked case (Fig. 402 A and B), the heel appears drawn up, the anterior part of the foot adducted and inverted, the inner border turned upwards or inverted, and the outer border downwards, so that the sole looks backwards and the dorsum forwards, the long axis of the foot being at the same time shortened and bent upon itself, the sole unnaturally concave, and the plantar fascia tense. In severe cases (Fig. 402 C), the inner border of the foot may be in contact with the leg, and when the foot has been walked upon the sole looks upwards as well as backwards, and the dorsum downwards as well as forwards; whilst the sole is narrowed by the approximation of the fifth metatarsal bone to the first, and a bursa often forms over the outer border of the dorsum. In the *acquired*

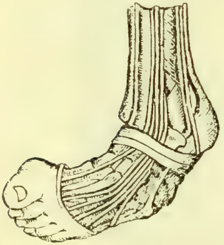

Fig. 401. — Congenital talipes varus. (St. Bartholomew's Hospital Museum.)

form, which is generally due to infantile paralysis, the history of the case, the wasting, shortening, coldness and passive congestion of the limb, and often the absence of rigidity, will commonly serve to distinguish it from the congenital.

3. *Talipes calcaneus* is rare. In the *congenital* variety (Fig. 403) the anterior part of the foot is drawn up and often a little everted or inverted, and generally held rigidly in this position by the contraction of the extensor muscles. In the *acquired* form (Fig. 403), which is commonly the result of infantile paralysis of the calf muscles, the heel is placed first on the ground in walking, but there is no drawing up of the foot by the extensors. The anterior part of the foot drops downwards from the transverse tarsal joint, and the tendo Achillis, instead of standing out tensely as in the normal foot, can often hardly be felt.

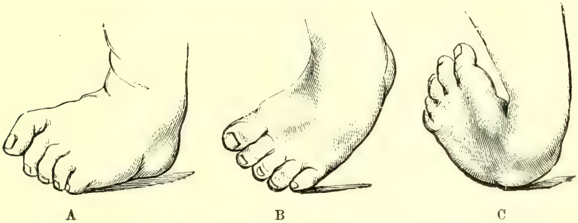

Fig. 402.—Congenital varus. Three grades of severity. (Bryant's Surgery.)

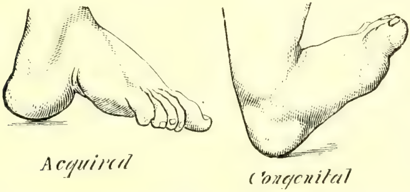

Fig. 403.—Talipes calcaneus. (Bryant's Surgery.)

4. In *talipes valgus or flat-foot* the longitudinal and transverse arches of the foot are flattened and the anterior part of the foot is more or less everted. Though rare as a congenital, it is very common as an acquired deformity, and as such is, perhaps, most often due to the yielding of the ligaments of the sole and the relaxed state of the muscles which normally support the plantar arches, in consequence of general debility and want of muscular tone, combined with long standing or carrying heavy weights with the feet abducted. Hence its frequency in growing and under-fed lads, errand-boys, policemen, waiters, housemaids, and the like.

Amongst other causes may be mentioned rheumatism, gonorrhœa, rickets, sprains of the plantar ligaments, and spasm or paralysis of certain muscles of the leg. It is also met with in badly-set cases of Pott's fracture. The calcaneo-scaphoid ligament and plantar fascia, and to a less extent the other ligaments of the sole, are elongated, and the bones on the inner side of the foot, instead of forming an arch, are depressed and in contact with the ground. The bones in front of the transverse tarsal joint are at the same time more or less abducted and everted, leaving the head of the astragalus, which is itself depressed, partly exposed on the inner side of the foot.

In severe, and generally in congenital cases, the heel and front of the foot are drawn up by the tendo Achillis and the anterior muscles respectively, whilst the outer border of the foot is raised from the ground. The acquired form is often productive of so much crippling and pain as to render the sufferer unable to follow any employment which necessitates much standing or walking. The foot (Fig. 404) looks broader and longer than natural, the sole is flat, the inner border in contact with the ground, and the internal malleolus depressed; whilst two prominences, formed by the tuberosity of the scaphoid and the partially exposed head of the astragalus, can be seen and felt projecting on the inner side of the foot. In slight cases the foot can be made to assume its natural form on manipulation or on standing on tip-toe, but in severe cases it is rigidly fixed in the deformed position. Pain and stiffness of the metatarso-phalangeal joint of the great toe (*Hallux dolorosus*) is a common concomitant of flat foot in boys and young adults.

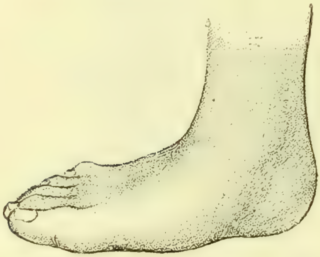

FIG. 404.—Talipes valgus or flat-foot. (St. Bartholomew's Hospital Museum.)

5. In *talipes varus* the sole is unnaturally arched and the plantar fascia is tense. The toes are often extended at the metatarso-phalangeal joint, and flexed at the first interphalangeal joints, giving them a clawed appearance (*hollow claw-foot*). This condition is said at times to be due to infantile paralysis affecting the interosseous muscles. I have tested the muscles in many cases but have not found them paralyzed.

GENERAL TREATMENT OF TALIPES.—The indications are—1, to restore the deformed foot to its natural position; and 2, to retain it in this position until the normal functions of the joints and muscles have been so far restored that there is no tendency to a relapse. In the congenital and in many of the acquired forms these indications can be successfully fulfilled if appropriate means are taken and sufficient time and care are given to the case. It is most important in congenital cases, and especially in congenital varus, to begin the treatment early, indeed it should be begun immediately after birth—as soon as the infant is washed, as Sayre puts it – and should be continued until no tendency is shown for the foot to relapse into the deformed position. In the paralytic varieties, where the muscles have undergone complete atrophy and degeneration, these of course cannot be restored, and the foot can only be maintained in the normal position by the use of instruments. For the fulfilling of the first indication manipulative, operative and mechanical treatment may be necessary. For the second, mechanical supports and physiological after-treatment should be employed.

Manipulative treatment consists in wrenching the foot with the hands into the best possible position and then securing it in this position with plaster-of-Paris bandages. The wrenching should be repeated once or twice a week. A thick layer of cotton wool should be placed beneath the plaster of Paris to prevent sores forming.

The *operative treatment*, when this is necessary, will generally consist in the subcutaneous divisions of certain tendons (*tenotomy*), in the division of contracted ligaments (*syndesmotomy*), and in inveterate cases in the excision or section of some of the tarsal bones (*tarsectomy* or *tarsotomy*), or in the performance of one or other of the following operations : Phelps' open incision ; Buchanan's subcutaneous section ; Fitzgerald's operation ; forcible rectification.

Tenotomy is indicated where there is much rigidity and the foot cannot be brought into its natural position by manipulation. Its object is the lengthening of the shortened tendon, not its mere division. The lengthening is effected by the organization of the small-cell-exudation which is poured out between the divided ends of the tendon. Hence the importance of subcutaneous division, that is, of making a mere puncture in the skin and preventing the entrance of septic matter lest suppuration ensue and the tendon become adherent to its sheath or fail to unite. The tendon having been made tense by an assistant, pass the tenotome beneath it with the blade on the flat; then whilst the tendon is slightly relaxed, turn the edge of the tenotome towards the tendon and cut towards the skin, the assistant again making it tense to facilitate the division, but relaxing the moment it is felt to give way lest the skin be severed and the puncture be converted into an open wound. The puncture should be covered with a dossil of antiseptic gauze, and the foot secured to a splint or in a plaster-of-Paris bandage. It was formerly the custom to place the foot on a splint in the deformed, or in only a slightly improved position for a few days, until the puncture had healed and the tendon had united, before beginning mechanical extension to stretch the new material between the divided ends. It was thought that if the foot was at once rectified and the ends of the divided tendon consequently much separated, there was grave risk of the tendon not uniting, or of the uniting material remaining weak. I have not, however, found this to be the case, and I now invariably place the foot immediately after tenotomy in the best position possible, often leaving a gap of a quarter of an inch to half an inch, or even more, between the ends of the divided tendon. By at once rectifying the position of the foot, after dividing any contracted ligaments that may still hold the bones in their deformed position, much time is saved and the necessity of expensive extension-apparatus is avoided. In dividing the posterior tibial tendon, after a puncture has been made with a sharp-pointed tenotome, a blunt-pointed tenotome should be substituted for it lest the posterior tibial artery be pricked. Should this vessel be wounded, all that is necessary is to apply firm pressure to the foot and ankle by a pad and bandage. On no account should an attempt be made to tie it, as this would convert the subcutaneous into an open wound. Even where the anterior as well as the posterior tibial artery has been wounded in tenotomy, bleeding has been readily arrested by pressure, and no harm has ensued. In the fat ankle of an infant the posterior border of the tibia, the guide to the tendon of the tibialis posticus, cannot be felt; the tenotome should then be entered midway between the anterior and posterior border of the leg, and at right angles to the surface.

Syndesmotomy consists in dividing the contracted ligaments which after tenotomy are frequently found to hold the foot in the deformed position. It is performed by passing a tenotome deeply into the foot over the situation of the ligaments to be divided, and cutting freely through them whilst they are put on the stretch by an assistant manipulating the foot. The position of the foot should then be rectified by wrenching, and a plaster-of-Paris bandage applied.

Tarsectomy has for its object the removal of certain bones or portions of bones from the tarsus, so as to allow the foot to be at once restored to its normal position. It should only be undertaken in inveterate cases after milder measures have failed. The operations most frequently performed are Davy's, or the removal of a wedge-shaped piece of bone from the tarsus; and Lund's, or the excision of the astragalus.

Tarsotomy is the operation of dividing the tarsus transversely with a chain saw, and, like tarsectomy, should only be done in inveterate cases.

Phelps' open incision.—This consists in making an incision through the soft tissues on the inner side of the foot down to the bones. The tibialis anticus and posticus, the abductor hallucis and the calcaneo-scaphoid ligaments are divided. The wound is then stuffed with aseptic gauze and allowed to granulate from the bottom.

Buchanan's subcutaneous section.—A tenotomy knife is passed between the skin and the plantar fascia half across the sole of the foot, and all soft parts,—the muscles, arteries, nerves, and ligaments are then divided down to the calcaneo-scaphoid joint.

Fitzgerald's operation consists in dividing subcutaneously with a chisel the neck of the astragalus, and the os calcis just behind the posterior articular facet for the astragalus, and in then drilling the cuboid in several places, breaking up subcutaneously the scaphoid with a chisel and hammering it back into place.

Forcible rectification.—This is done by a Thomas' wrench or by Grattan's, Rédard's, or some other form of osteoclast. The ligaments preventing reduction are torn across and sometimes the bones are broken.

Mechanical treatment.—Until recently it was usual to keep the foot in the deformed position till the tendons had united, and then bring the foot slowly into its normal position by gradually stretching the united tendon. The apparatus usually employed was some form of Scarpa's shoe (Fig. 405) or other cog-wheel contrivance. By the majority of surgeons, however, plaster of Paris is now substituted for such expensive apparatus, the foot being secured at once in the plaster in the best possible position. In slight cases division of the tendon will alone be sufficient to allow of this; in more severe cases the division of the ligaments will also be necessary, whilst in very severe cases removal of a portion of bone will be required. If plaster of Paris is used a cotton-wool bandage should always be employed beneath the plaster to prevent injurious pressure on the parts. The mechanical supports necessary after the foot has been rectified will be briefly mentioned under the treatment of each variety of talipes.

Physiological after-treatment is most important for the purpose of restoring the natural movements of the joints and the functional activity of the muscles. It consists in active and passive exercises, massage, Faradization, hot and cold sponging, and lastly, in teaching the patient the proper use of the restored foot.

It now remains to mention the special treatment appropriate to each variety of talipes.

In *talipes equinus*, tenotomy of the tendo Achillis is usually all that is required; but if there is much contraction of the sole (*talipes cavus*), the plantar fascia, or any tense band that can be felt, should first be divided, and when the sole has been straightened out by keeping the foot for a fortnight or so in plaster of Paris, the tendo Achillis may then be cut, and the foot again placed in plaster in the restored position for another two or three weeks. A boot with double leg-irons and toe-raising spring must be subsequently worn in paralytic cases, the irons being carried above the knee and the outer iron above the hip to a pelvic band if the flexors or extensors of the leg are also affected (Fig. 406).

In *congenital talipes varus*, treatment cannot be begun too early. In very slight cases the foot should be held in the restored position for some hours daily by the nurse's hand, or in slightly severer cases fixed in the restored position by plaster of Paris or a varus splint. If this, combined with some wrenching, does not suffice, the tibialis anticus and posticus should be divided, and the inversion of the foot overcome by some form of varus splint, or plaster of Paris. When this has been thoroughly done, the tendo Achillis should be cut, and the heel brought down as in *equinus*. Where there is much contraction of the sole, the plantar fascia, or other tense band, should be divided after the tibials but before the tendo Achillis. A similar instrument to that described for equinus should then be worn for a year or more; or as long as any tendency is shown to relapse. In paralytic cases, where the whole leg tends to twist inwards from the hip-joint, the outer iron should be carried to the pelvis. In very severe cases the ligaments on the inner side of the sole and the posterior ligament of the ankle may be divided subcutaneously, as suggested by Mr. R. W. Parker (*syndesmotomy*); or, if this is not enough, the whole of the soft tissues on the inner side of the sole may be divided subcutaneously down to the bone (*Buchanan's operation*), or the contracted tendons and ligaments below and in front of the internal malleolus may be divided by an

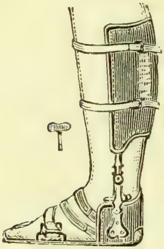

Fig. 405.—Scarpa's shoe.

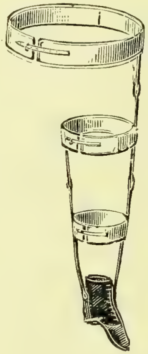

Fig. 406.—Boot with double leg-irons to above knee, outside iron continued to pelvic girdle.

open incision (*Phelps' operation*), or as a last resource a wedge-shaped piece from the transverse tarsal joint, or the astragalus, may be removed.

In *talipes calcaneus*, the extensor tendons, in the congenital form, must be divided if the foot cannot be rectified by plaster of Paris alone. In the acquired form a boot and irons, similar to that used in equinus but with a toe-depressing spring, may be worn. In paralytic cases the tendo Achillis may in some instances be shortened by removing half an inch or more and splicing the divided ends, or the peronei may be sutured to the tendo Achillis so as to take the place of the paralyzed calf muscles (*Nicoladoni's operation*).

In *talipes valgus* or *flat-foot*, such exercises as alternately raising the body on tip-toe, or walking on the outer edge of the foot, will in slight cases of the acquired variety when combined with the use of a valgus pad and a properly shaped boot, generally be successful. In severer cases a boot with outside leg-iron and rubber band to brace up the sunken arch (Fig. 407), should be worn ; whilst where there is much rigidity, the foot should be wrenched into position with the patient under an anæsthetic and placed in plaster of Paris for a month. The wrenching may be repeated if necessary, and the boot above described subsequently worn. In very severe cases excision of Chopart's joint (*Ogston's operation*), the removal of a wedge-shaped piece of the neck of the astragalus and osteotomy of the tibia just above the ankle have been performed, and are said to be attended with success. I have on only one occasion had to do Ogston's operation, having always found wrenching sufficient. By some surgeons, division of the peronei tendons is recommended, a procedure which, in my opinion, is quite unnecessary, and contrary to the principles which should guide us in the treatment of the deformity.

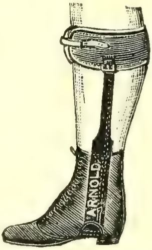

FIG. 407.—Author's boot for flat-foot.

HALLUX VALGUS is the dislocation of the great toe inwards at the metatarso-phalangeal joint. It is frequently connected with an enlarged bunion over the inner side of the joint. In the way of treatment a sock with a separate stall for the big toe should be worn and the boots should be straight along the inner edge and square at the toe. Krohne's lever, Bigg's bunion spring, or Holden's toe-post in the boot will be found useful in correcting the inward displacement. If the toe-post is used a gloved stocking must be worn. For advanced cases, excision of the head of the metatarsal bone is attended with the best results.

HAMMER TOE (Fig. 408) is a condition in which usually the second toe is hyperextended at the metatarso-phalangeal joint and flexed at the first interphalangeal joint. It is due to contraction of the lateral ligaments and glenoid plate (not to contraction of the tendons), the result, in probably the majority of cases, of wearing too short or badly-shaped boots. It is sometimes hereditary, however, and Mr. Anderson regards it as due to a physiological contraction of the ligaments, and only in a remote sense to the use of ill-formed boots. A bursa, surmounted by a painful corn, is generally found over the head of the prominent first phalanx (Fig. 408), and a valgoid condition of the great toe, which then generally overlies the second toe, is usually present. *Treatment.*—Wrenching the toe, dividing the ligaments subcutaneously, excising the joint, or amputating the toe according to the degree of deformity, is the usual treatment. The way I have treated this troublesome affection of late has been to make an incision over the inner side of the first interphalangeal joint down to the bones. The lateral ligaments are next divided, and the head of the first phalanx made to protrude. It is then cut off with bone scissors, and the wound accurately closed. The foot is placed on a splint provided with slots for securing the toe by means of a bandage in the straight position. The corn and bursa are removed at the time of the operation, through a small oval incision round the corn.

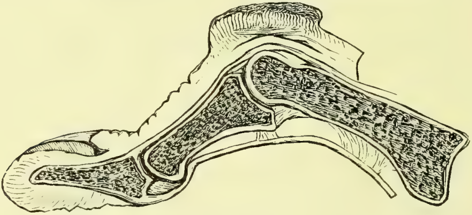

Fig. 408.—Hammer toe. (St. Bartholomew's Hospital Museum.)

APPENDIX.

AMPUTATIONS.

Amputations.—The objects that should be kept in view in performing an amputation are:—1, to remove the whole of the injured or diseased part that is beyond the reach of recovery, with as little sacrifice of the healthy tissues as possible; 2, to prevent all unnecessary hæmorrhage; 3, to secure a sufficient covering for the end of the bone; 4, to avoid adhesion of the cicatrix to the bone; 5, to divide the large blood-vessels and nerves transversely, and leave their cut ends in such a part of the stump that they may be little exposed to pressure; and 6, to ensure an efficient drain and aseptic condition of the wound.

Amputations may be performed by the *circular* or by the *flap* method.

In the *circular method* the integuments are first divided by a circular incision round the entire circumference of the limb. They are then retracted, and the muscles divided higher up the limb by a similar circular sweep of the knife. The muscles are next in their turn retracted, and the periosteum is divided still higher up the bone, which is finally sawn through at that spot. This method possesses the advantages that the vessels and nerves are divided transversely, and that the wound is of moderate dimensions; but the cicatrix is opposite the end of the bone, the coverings for the latter are apt to be deficient, and the stump is liable to assume a conical shape. The circular method is now seldom employed, except for amputation of the arm.

In the *flap method*, double flaps, or a single anterior or posterior flap, are provided for the covering of the bone. The flap or flaps may consist of integuments alone, or of more or less of the muscular and other soft tissues as well. In the former case the flaps are cut and reflected, and the muscles and other soft parts are then divided at the level of the base of the flaps in a circular manner down to the bone, which is sawn through a little higher up. By this method most of the advantages of the circular amputation are secured without its disadvantages. When, on the other hand, the muscles are included in the flaps, the vessels and nerves are liable to be split, or notched, or divided obliquely instead of transversely, whilst the mass of muscle in the flaps tends to prolong the healing of the wound. These muscular flaps may be cut either from without inwards, *i.e.*, from the circumference towards the bone, or from within outwards, *i.e.*, by the method of transfixion. In whichever way the flaps are cut, and whether they consist of integuments only, or of integuments and muscle, they may as regards position be antero-posterior or lateral, or one may be antero-external, and the other postero-internal, or *vice versâ*. As regards length they may be equal, or one may be long, the other short; and as regards breadth they should be half the circumference of the limb. As a rule they should be cut square, but with rounded angles. The following modifications of the flap operation may be briefly mentioned.

Teale's method consists in making a long and a short rectangular flap (Fig. 409). The long flap, which is generally anterior, or antero-external, is quadrilateral in shape, and its length and breadth each equal to half the circumference of the limb; it includes all the soft parts down to the bone. The short flap is posterior, or postero-internal; its length is one-fourth the anterior, and its breadth equal to half the circumference of the limb; it also includes all the soft parts down to the bone, and contains the large vessels and nerves. When the operation is completed and the wound closed the stump presents the appearance shown in the lower half of Fig. 409. The advantages claimed for Teale's method are:—1, freedom from tension; 2, a complete covering for the bone free of large vessels and nerves; and 3, a dependent position of the wound. It is applicable to amputations through the leg, arm, forearm and lower third of the thigh.

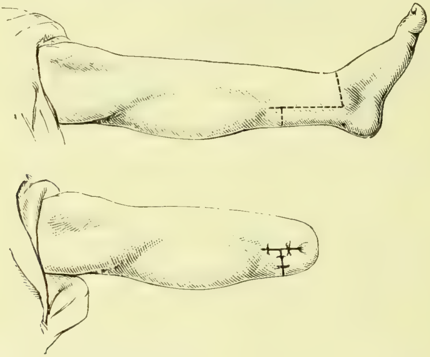

Fig. 409.—Teale's amputation. (Bryant's Surgery.)

Carden's method, designed for amputating through the condyles of the femur, consists in reflecting a semi-oval flap of integuments, half the circumference of the limb in length and breadth, from the front of the knee-joint, dividing everything else down to the bone by a circular sweep of the knife, and sawing the bone across slightly above the plane of the divided muscles.

SPECIAL AMPUTATIONS.—*Amputation at the shoulder-joint* may be performed either by the flap or by the oval method. In either case the subclavian artery should be compressed above the clavicle, or in some instances the axillary tied before the amputation is begun. *The flap method.*—A large flap consisting of integuments and deltoid muscle is usually taken from the outer aspect of the joint, either by transfixion or better by cutting from without inwards. In *transfixion*, the deltoid having been grasped and raised by the surgeon's left hand, the knife should be made to transfix the limb on its upper and outer aspect just below the acromion, and a flap formed with rounded angles about four inches long. The flap is turned back, the head of the bone freed from its connections, and the knife passed behind it, and made to cut its way out towards the axilla, the axillary artery being seized as it is divided. In cutting a flap from *without inwards*, the incision is made from a point just external to the coracoid process and carried in a circular sweep downwards as low as the insertion of the deltoid, and then upwards to the posterior fold of the axilla just behind and below the acromion. In the *oval* method (*Spence's modification*), an incision is made from just external to the coracoid vertically downwards as in excising the joint "through the clavicular fibres of the deltoid and pectoralis major" to the humeral attachment of the latter muscle, which is then divided. The incision is next carried with a gentle curve through the lower fibres of the deltoid towards the posterior border of the axilla. A second incision is then made through the skin and fat only, from the point where the straight incision terminated across the inside of the arm to meet the incision at the outer part. The outer flap is next dissected up with the trunk of the posterior circumflex artery, the head freed from its connections, disarticulated, and the remaining soft parts cut through on the axillary aspect, the axillary artery being divided last of all.

Amputations of the arm and forearm are usually performed by double skin-flaps and circular division of the muscles. The circular method, however, or amputation by single or double transfixion or by Teale's method may be employed.

Amputation at the wrist may be performed by two short flaps, by a long palmar flap, or by an external flap taken from the thumb. In the double-flap method the incision is commenced half an inch above the styloid process of the radius or ulna. The flaps should be cut square, with rounded angles, and about two inches in length. The joint should be opened on the dorsal aspect, and on the completion of the disarticulation the styloid processes of the radius and ulna sawn off.

The *thumb* at the carpo-metacarpal joint may be amputated by transfixion or by an oval incision. In the *transfixion* method the point of the knife in operating on the right side is entered at the web of skin between the first and second metacarpal bones, and made to emerge on the palmar aspect of the carpo-metacarpal joint. A palmar flap is then cut from the tissues forming the ball of the thumb, and the knife drawn obliquely across the back of the thumb from one extremity of the flap to the other. In operating on the left side, the oblique incision across the back of the thumb is first made, then the point of the knife is thrust down through the web and made to transfix as on the right side. In the *oval or circular* method, the knife is entered midway between the base of the metacarpal bone and the styloid process of the radius, and the incision carried obliquely along the dorsum of the metacarpal bone to the first phalanx, and then round the palmar surface and back again to the former incision.

The *fingers* may be amputated by double flaps or by a long anterior flap. In amputating a finger it should be remembered that the joint is in front of the knuckle. If the whole finger requires removal, the head of the metacarpal bone should be nipped off with bone forceps, unless breadth and strength of hand is the chief desideratum, when it should be left.

Amputation at the hip-joint may be done by transfixion or by Furneaux Jordan's method. Although the former can be performed with greater celerity, the latter is by far the better operation, as it is attended with less hæmorrhage and provides a much more useful stump. In the *transfixion method* a long anterior flap is made by transfixion and cutting towards the surface. The knife is entered midway between the anterior superior iliac spine and the great trochanter, and is made to emerge as near to the tuberosity of the ischium as possible. A flap about ten inches long is then cut, the vessels being seized by the fingers of an assistant, who grasps them with the flap and turns it upwards. The limb is then everted and extended by an assistant, the joint opened, the head of the bone and great trochanter freed from their connections, and the knife carried straight out posteriorly. Hæmorrhage should be controlled by Davy's lever in the rectum, or by Lister's abdominal tourniquet. In *Furneaux Jordan's method*, Esmarch's cord tourniquet having been applied, a circular amputation is first done through the upper third of the thigh, and all the vessels secured. The tourniquet is then removed, and an incision carried up the outer side of the thigh to the great trochanter, the soft parts with the periosteum separated from the bone, the joint opened and the disarticulation completed by freeing the remaining connections with the knife kept close to the bone.

Amputation through the knee is perhaps best done by lateral flaps after Stephen Smith's method. Two lateral skin flaps are cut from each side of the limb, the incisions beginning in front, an inch below the tubercle of the tibia, and ending behind at the centre of the popliteal space. The soft tissues are next divided by a circular sweep of the knife just below the patella, and the tibia then separated from the femur. The patella is left in the stump. The inner flap should be slightly the larger.

Amputation of the thigh is usually done by double skin-flaps and circular division of the muscles. The flaps may be antero-posterior, or lateral; or one flap may be antero-external and the other postero-internal.

Amputation of the leg may also be done by two skin-flaps and circular division of the muscles, or by Teale's method. The posterior flap is sometimes cut by transfixion. The sharp edge of the tibia should be cut off obliquely, lest it subsequently protrude through the skin. The division of the fibula should be completed before that of the tibia to prevent splintering. Should the arteries retract, as they are apt to do in this situation, they may be conveniently drawn down by a tenaculum.

Amputation of the foot may be done by one of the following methods:—

Disarticulation at the ankle-joint (*Syme's amputation*) consists in removing the foot at the ankle-joint, cutting off the ends of the tibia and fibula, and retaining the integuments of the heel as a covering for the bones. An incision down to the bone is made across the under surface of the heel from the tip of the external malleolus to a little behind and below the internal malleolus, *i.e.*, to a point exactly opposite its commencement. This incision should incline slightly backwards, so as to cross the os calcis just in front of the tubercles (Fig. 410, 1 to 0). A second incision is next made across the front of the ankle (Fig. 410, 0 to 1′), the joint opened, the lateral ligaments divided, and the os calcis cleared from its posterior and lateral connections by cutting from above downwards. Syme, however, formed his heel-flap by dissecting it from the bone from below upwards, a more difficult procedure than cutting from above downwards as is now always done at St. Bartholomew's. The knife should be kept close to the bone to avoid injuring the posterior tibial artery or button-holing the integuments. The malleoli and a thin slice of the tibia are finally sawn off (Fig. 410, A). The anterior tibial and the plantar arteries require ligaturing; the latter are situated at the extremity of the inner side of the heel-flap.

Pirogoff's operation is a modification of Syme's. It differs in that the posterior part of the os calcis is left in the heel-flap to unite with the sawn end of the tibia. It is performed in a similar manner, save that the sole-incision is carried slightly forward instead of backward (Fig. 410, 0 to 4), and after the ankle-joint is opened, and the os calcis exposed, the posterior part of the latter is sawn off (Fig. 410, D) instead of being dissected out. The sawn surface of the os calcis is then turned up and placed in contact with the sawn end of the tibia, to which it may advantageously be fixed by an ivory peg driven through the heel-flap and os calcis into the lower end of the tibia.

The *Medio-tarsal amputation* (*Chopart's*) consists in amputation of part of the foot through the transverse tarsal joint, *i.e.*, the joint formed by the os calcis and astragalus behind, and the cuboid and scaphoid in front (Fig. 410, B). A curved incision with its convexity forwards is made across the dorsum of the foot from immediately behind the tubercle of the scaphoid to a point midway between the tip of the external malleolus and the base of the fifth metatarsal bone (Fig. 410, 2 to +). The extremities of this incision are connected by tracing out from the sole a flap which should reach just short of the balls of the toes, and should be longer on its inner than on its outer side (Fig. 410, + to 2′). The dorsal ligaments are now divided, and the knife is passed beneath the bones and made to cut its way outwards, thus completing the flap already marked out on the sole. The astragalus and os calcis are, of course,

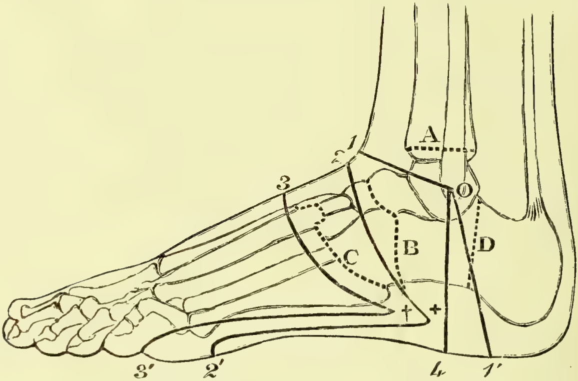

Fig. 410.—Diagram of the articulations of the foot and the lines of incision in the various amputations.

A, line of incision through malleoli in Syme's amputation. 1 to 0, 0 to 1′, lines of incision through soft parts in Syme's amputation. D, line of incision through os calcis in Pirogoff's operation. 1 to 0, 0 to 4, lines of incision through soft parts in Pirogoff's operation. B, line of articulation between os calcis and astragalus behind and cuboid and scaphoid in front. 2 to +, + to 2′, lines of incision in Chopart's operation. C, line of articulation between tarsus and metatarsus. 3 to †, † to 3′, lines of incision in tarsometatarsal operation.

left in the stump. The chief objection that has been urged against the operation is the tendency of the tendo Achillis to draw up the os calcis, and consequently depress the anterior part of the stump so that the cicatrix becomes the lowest part. If care, however, is taken to make the dorsal incision nearly straight across the foot, this drawing up of the heel can to a great extent be prevented and an excellent and useful stump may be obtained, or Tripier's suggestion may be adopted and the under surface of the os calcis be sawn off so as to leave a flat surface for walking upon.

The *Tarso-metatarsal amputation* consists in removing the anterior part of the foot at the joints between the tarsus and metatarsus (Fig. 410, C), leaving the tarsus intact. It may be done—1, by disarticulating the metatarsal bones; 2, by sawing across the bases of all the metatarsal bones; 3, by disarticulating the four outer metatarsal bones and sawing across the projecting internal cuneiform bone; 4, by disarticulating the three outer and the first metatarsal bones, and sawing across the prominent base of the second. The disarticulating method is usually called Lisfranc's operation; the disarticulating, with sawing across the internal cuneiform or base of the second metatarsal bone, Hey's. Hey, however, it appears, performed all of the first three operations, but not the last; and so much confusion has arisen as regards what is meant by Lisfranc's and what by Hey's operation that the terms had better be dropped. In the disarticulating method, which only need be described, an incision is made across the tarsus from the fifth metatarsal bone to an inch in front of the prominence of the scaphoid (Fig. 410, 3 to †); a sole-flap is next traced out, as in Chopart's amputation, but it should reach as far as the web of the toes (Fig. 410, † to 3′). The metatarsus is then disarticulated from the tarsus, the only difficulty in doing this arising from the second metatarsal bone dipping in between the cuneiform bones. The knife is now placed behind the bones and made to cut its way out, thus completing the sole-flap, or the flap if preferred may be dissected up from without inwards.

The *great toe* may be amputated at its tarso-metatarsal joint by a flap taken from the inner side of the foot; or by an oval incision which is carried along the metatarsal bone to about the middle of its shaft, then made to diverge to the web between the first and second toes, and carried round the plantar surface of the big toe and back to the spot at the middle of the metatarsal bone. The incision should extend down to the bone, which should be next freed from its remaining connections and disarticulated, the knife being kept close to the metatarsal bone to avoid injuring the communicating branch of the dorsalis pedis with the external plantar artery. When the operation is completed merely a single longitudinal scar remains on the inner side of the foot.

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